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ORIGINAL ARTICLES.

I.—A large Labyrinthodont Tooth from the Upper Karroo Beds of Wonderboom, near Burghersdorp.

By Professor H. G. Seeley, F.R.S., F.L.S., F.G.S., King's College, London.

PLATE X.

THIS vomerine tooth was found by Dr. D. R. Kannemeyer when a resident at Burghersdorp. It is the only evidence of the dentition of the animal known, and is interesting as being of much larger size than any Labyrinthodont teeth hitherto found in South Africa, though smaller than the large teeth of *Mastodonsaurus gigas* from the Keuper of Würtemburg. Its presumed position on the palate is based upon the anchylosis of the tooth with a bone which shows a flat oblique suture at the base of the crown. This suttural surface is usual on vomerine teeth, and indicates that the tooth was directed downward, outward, and a little backward.

The base of the crown is closed and convex, and appears to be formed of dense tooth substance in which a labyrinthic structure is visible. On one side of the base there is a smooth surface, convex from above downward, concave from side to side, which is imperfectly preserved. This surface extends on to the palate, and is an indication of a vacuity, situated probably beneath an anterior nasal aperture. The bone about the base of the tooth projects all round it as a slight collar.

The tooth is broken transversely, 1½ inch of the length of the crown is preserved in front, and little more than one inch on the hinder border. The total length to the base is about 2 inches. This may indicate, by approximation of the lateral curvatures, an original length of 2½ inches. The base is transversely ovate, rather wider in front than behind, and rather more convex on the outer than on the inner side. But this irregular sub-triangular ovoid form is soon lost, and at the superior fracture the tooth is circular, with a diameter of more than half an inch.

The external surface is marked with close-set fine linear ribs, which are flattened and have a tendency to be gathered into bundles, by the grooves from time to time becoming deeper, especially in

the lower part of the crown, where the number of ribs is greater. They do not often show dichotomous division; but the ribs which rise from the base irregularly die away in the grooves. They have an appearance of being finer and more numerous in the lower part of the crown than at the transverse fracture, where they number about eighty. There is practically no enamel on the crown, which shows only a faint surface gloss. On receiving the tooth I had a cast made, and a transverse section was prepared so as to show the labyrinthic structure of the crown. The cut surface now has the appearance of being bordered at the circumference by close-set tubes which correspond to the external vertical ribs. Under the microscope these sections of the reed-like sheath of the tooth are mostly sub-quadrate, and hollow; separated from each other by a narrow band which passes inward and folds into the labyrinthic substance of the tooth. The centre of the crown of the tooth is occupied by the pulp cavity, nearly circular, slightly longer than wide; with a number of fine films at irregular intervals, radiating outward from it as vertical plates dividing the folded tooth substance.

The folding of the dentine is more complicated than in any genus yet examined. Counting from the inner border there are about twenty-five folded labyrinthic plates of dentine, which radiate to the circumference, without greatly varying in width. Each of these plates is made up of twelve or more alternate folds to right and left of the tooth substance, with each fold often plicated, and including spaces more or less small, frequently ovate, sometimes more elongated. The dentine is composed of tubes which show a radiating arrangement in harmony with the curvature of the folds. Each layer bears a thin film upon its external infolded surface which appears to correspond in position to enamel. This layer passes outward between the folds of dentine, and appears to extend over the external surface of the tooth, though most of the enamel is manifestly lost. Between the folded plates are a series of supplementary wedge-shaped folds, about half as numerous, which are continuous with the dentine of the plates on each side, sometimes by its being folded over on the one side, and connected by anastomosis on the other side.

The most distinctive features of the tooth are: (1) the external layer of vertical tubes of dentine; (2) the denseness of the folding of the dentine; (3) the connection of the folds with each other in ways different to those known in *Mastodonsaurus*; and (4) the number of small vacuities included in the folds of the dentine.

The only clue to the form of the skull is given by the small palatal vacuity, presumably palato-nasal, which descends upon the base of the tooth, and may be evidence that the skull was broad, depressed convex in front, with the nares in a forward position. The only genus with the skull of this type hitherto indicated is the imperfectly known *Batrachiosuchus* of Dr. R. Broom; but that type is far too small to have carried teeth of this size, which may indicate a skull twice as large, or about 18 inches long. The teeth in *Batrachiosuchus* are undescribed. I do not anticipate that it will prove referable to *Ptychosphegodon* (Geol. Mag., 1907, Dec. V, Vol. IV, p. 435), but it is from an animal equally large.

There are no grounds for generic definition at present, but the genus is probably undescribed. And in the absence of evidence of other generic characters than the dense folding of the tooth substance it may be sufficient to record the species as *Syphonodon thecomastodon*.

The photographs were made for me by A. Campion, Esq., in the Metallurgical Laboratory, Coopers Hill. The transverse section is enlarged four diameters and the segment is enlarged twelve diameters.

EXPLANATION OF PLATE X.

FIG. 1.—Transverse section of the summit of the crown of the tooth of the Labyrinthodont reptile *Syphonodon*, rather more than four times the natural size; broken on the margin in polishing.

FIG. 2.—A segment of a transverse section of the same tooth, about twelve times natural size, showing a few of the radiating plates of folded tubes of dentine. Externally a few of the close-set quadrate tubes are seen which form the sheath to the tooth and suggest the trivial name *thecomastodon*.

II.—On some Recent Wells in Dorset.
(Part II.)

By W. H. Hudleston, M.A., F.R.S., F.G.S.

(*Concluded from the May Number, p.* 220.)

II. The Bovington Borehole.

FOR some years past the troops encamped at Bovington had to be content with such water as was supplied by a well a few hundred yards to the S.S.E. of the recently excavated borehole. The following particulars have been gathered respecting this well, but I cannot guarantee that in all respects they are strictly accurate. It was sunk in the Bagshot Beds about 1899, and is said to be 87 feet deep; the water-level stands at 82 feet from the surface, and the yield is 360 gallons per hour. The same Bagshot water-level was struck in the borehole. On comparing these two water-levels it is found that the one in the borehole stands at 85 feet above Ordnance Datum, whilst that in the well stands at 73 feet above O.D. This difference of 12 feet in a horizontal distance of 450 feet amounts to 1 in 37·5, showing a dip in the Bagshot Beds of 1½° to the S.S.E. This may not exactly represent the direction of maximum dip, but there are good reasons for believing that the line of maximum dip of the Bagshots hereabouts is not far from S.S.E.

Since the War Office was not satisfied with the amount of water yielded by the well they bethought themselves of obtaining an artesian supply, and accordingly entered into a contract for the execution of a borehole, which was to be prosecuted to a depth of 500 feet, unless a good supply of water was reached at a less depth.[1] Ultimately the boring was continued to a depth of 726 feet, and the following is a record of the beds encountered:—

[1] The engineers employed were Messrs. Le Grand & Sutcliff. The operations lasted from July to November, 1906.

	Thickness. ft. in.	Depth. ft. in.
SUPERFICIAL (14 feet).		
Soil	1 0	
1. *Marly Clay*[1]	2 0	
2. *Gravel.* Plateau-gravel with yellow flints	11 9	14 0
BAGSHOTS (151 feet).		
3. *Sand with loam bands.* Coarse, yellowish sand of uniform sized grain invested with ferric oxide. The '*loam bands*' consist of fine white powdery loam	20 0	34 0
4. *Coloured clay and sand.* Fine sediments, mostly discoloured and clayey	10 0	44 0
5. *Brown sand.* Loose sugary sand	4 0	48 0
6. *Light grey sand*	3 0	51 0
7. *Loose grey sand.* Sharp quartzose, clean	7 0	58 0
8. *Coloured sandy clay.* Whitish clay, slightly stained with iron; sets hard	4 0	62 0
9. *Coarse sand.* Loose, yellowish, coarse quartzose sand with small fragments of soft white silica, and one or two largish pebbles of lignite (see No. 17)	[water-level 85] 29 0	91 0
10. *Coloured clay and sand.* 'Two-ball' pipeclay	6 0	97 0
11. *Live sand.* Loose yellowish sand, rather coarse and with specks of soft white silica	24 0	121 0
12. *Blue clay.* A fine, unctuous, grey clay, like some of the grey pipeclays	12 0	133 0
13. *Coloured clay and sand*	4 0	137 0
14. *Live, coarse sand.* A very clean, angular quartzose grit, said to be full of water. Would make good building sand ...	18 0	155 0
15. *Brown coarse sand (live).* Similar to the above, but dirty ...	10 0	165 0
LOWER TERTIARIES (115 feet).		
16. *Sand and pebbles.* Coarse, dirty greyish sand with black flint pebbles (of the Blackheath type), and some small buff pebbles of another material	1 0	166 0
17. *Sand and wood.* Fragments of lignite	0 6	166 6
18. *Clay, sand, and pebbles*	4 6	171 0
19. *Dark sandy clay, hard*	9 0	180 0
20. *Coloured clay and pebbles*, reddish	5 0	185 0
21. *Dark sand and clay.* Dries pale grey and sets rather stiff ...	42 0	227 0
22. *Dark clay and stones.* The stones are of irregular shape, (?) corroded flints	1 0	228 0
23. *Live sand.* Fine, pulverulent, grey sand, not very loose ...	19 0	247 0
24. *Coarse sand and pebbles*, live (i.e. water)	5 0	252 0
25. *Mottled clay.* Light brown in colour...	5 6	257 6
26. *Hard dark clay and sand*	4 6	262 0
27. *Hard grey sand with some clay*, sets like a sandstone ...	13 0	275 0
28. *Green sandy clay and flints at bottom.* An earthy greensand, ranging from pale green to darker green: the flints are green-coated, mostly unworn and somewhat corroded ...	5 0	280 0
CHALK (proved to depth of)	446 0	726 0

It is a decided gain to have obtained the exact particulars of the Tertiaries, both as to character and thickness, in any one spot in the county, and these the Bovington Borehole supplies. Without doubt the Bagshot Beds are much thicker towards the centre of the basin, at Worgret for instance, than they are here, so near to their outcrop, nor can we say for certain whether this difference is wholly due to removal

[1] The italics represent the descriptions of the foreman of the works.

of the upper beds by denudation or to less deposition within the area. As might be expected, the Bagshots maintain their reputation as a sandy series, but there is a certain amount of the usual clays, some iron-stained, or mottled red, and some approaching the character of pipeclay. Nos. 10 and 12 may to a certain extent represent the famous Pipeclay horizon of the Creech district, and their position in the series is not inconsistent with this supposition. There is a marked change in the character of the sediments below No. 15, which may fairly be taken as the base of the Bagshots. In No. 16 we first encounter the black flint pebbles so characteristic of a London Clay horizon, but the Lower Tertiaries throughout the county are so extremely uninteresting, both from an economic and a geological point of view, that there is no need to dwell upon details beyond pointing out that No. 25 probably represents the plastic clays in the lower part of the Reading Beds which are much used for brickmaking in Dorset.

Owing to the method of boring it was not possible to ascertain whether the Chalk is fossiliferous here, so that no question as to horizon can be entertained. Assuming that the usual thickness of the Chalk in Dorset is about 900 feet, the bottom of the borehole is just half-way through that formation. There was no supply of water in the topmost Chalk until a depth of 70 feet was reached, but the first great supply was obtained a little below 400 feet, when the water-level rose to within 96 feet of the surface. The artesian pressure, therefore, was equal to raising a column of water nearly 200 feet into the Tertiaries in addition to 70 feet of waterless Chalk. The War Office not being satisfied with the Upper Water Supply, boring was continued, when a lower and increased water supply was obtained, bringing up the total to 60,000 gallons per day, and the water-level was raised to 93 ft. 6 in. below the surface. It should be noted here that hydrostatic pressure may, to a certain extent, be reduced by springs on the south side of the syncline, such as those outside Wool, which are about 75 feet above O.D. Moreover, in that direction the protective cap of Lower Tertiaries soon fails (see Fig. 4). The main water occurred between 675 feet and 685 feet.

The borehole is situated about half a mile above Bovington Farm-house on the west side of the road which divides Bovington Heath from Wool Heath. There is a patch of Plateau-gravel on the hillside, and it is on this platform that the mouth of the borehole is situated 170 feet above O.D. The crest of the hill due north of this position is about 1¼ miles distant, and there the Plateau-gravel attains an elevation of 283 feet at the high end of Wool Heath. The nearest outcrop of the Lower Tertiaries (London Clay and Reading Beds) is in the Moreton plantations, 1½ miles N.N.W., and the nearest outcrop of the Chalk is about 2½ miles distant in the same direction (not in the line of section). Along the line of section, north and south, the distance of the two outcrops of Chalk, across the syncline, is a little under 4½ miles, and this gives the width of the Tertiary basin through Bovington. The fact is that, previous to its final disappearance, about two miles east of Dorchester, the Tertiary basin is very much narrowed in the vicinity of Wool and Bovington owing to the northerly advance of the Chalk on the south side of the synclinal. A line drawn

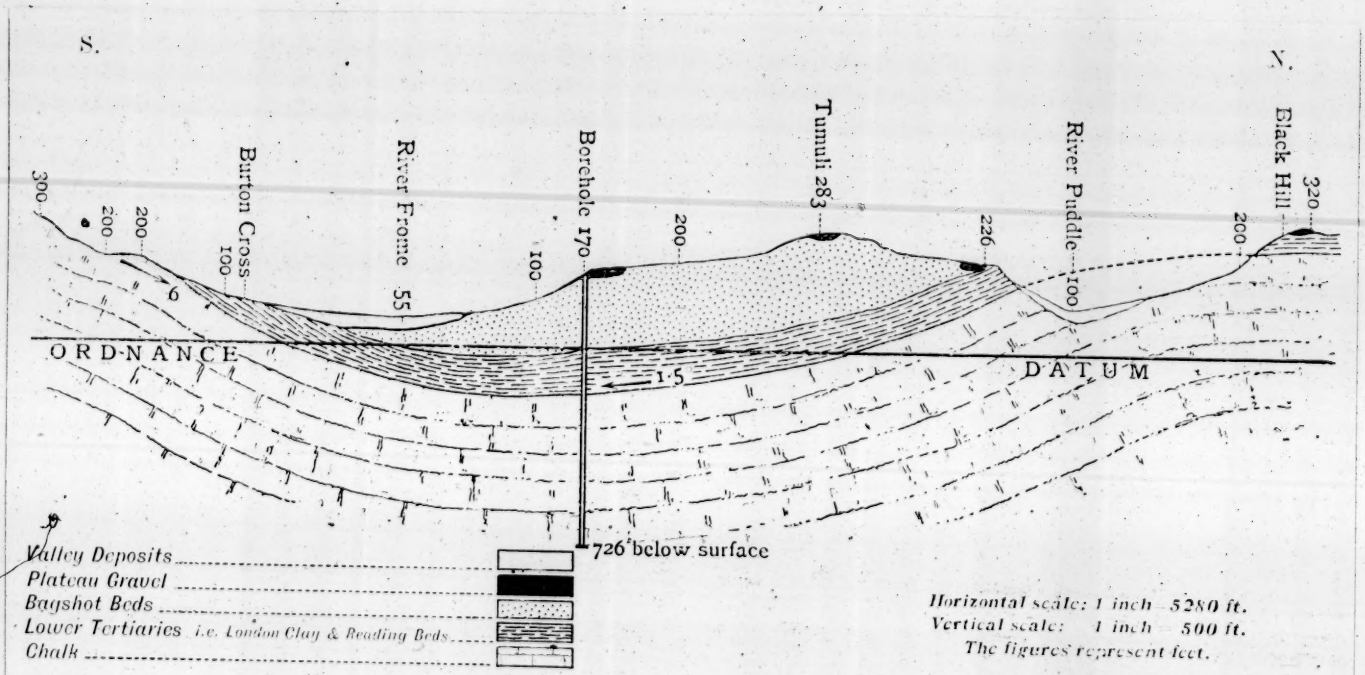


FIG. 4.—TRANSVERSE SECTION THROUGH THE DORSET SYNCLINE, SHOWING THE GEOLOGICAL POSITION OF THE BOVINGTON BOREHOLE.

across the basin through Holme instead of through Wool, shows a width of nearly nine miles, as against the 4½ miles through Wool or Bovington.

When we come to study the geological position of the Bovington Borehole, the measurements of the Borehole section, in conjunction with the surface plotting based upon the ascertained contours, enable us to obtain a fairly accurate conception of the prevailing conditions. The true axis of the tectonic syncline (see Fig. 4) can only be fixed approximately, but in this case it probably almost coincides with the axis of the Frome valley, which here runs very nearly in the trough of the syncline. On the meridian of Worgret near Wareham, on the other hand, the bed of the Frome lies a long way south of the synclinal axis. Generally speaking, the southern limb of the Dorset syncline is shorter, and therefore steeper than the northern limb. In this case a northerly dip of 6° is assigned to the south limb above Burton Cross, on the strength of dips observed in the Chalk near Wool. According to statements previously made in this paper, there is reason to believe that the northern limb in the neighbourhood of the borehole has a dip from 1·5° to 2° southwards, taking a sort of average, although there may be subsidiary folds within the general syncline. This is in conformity with the general rule that the dip of the northern limb is at a lower angle than that of the southern one.

From the Bovington Borehole to the margin of the Chalk escarpment near Bulbarrow is a distance of about twelve miles in a northerly direction, and if we deduct three miles for areas covered by Tertiaries along this line, there remains nine miles of Chalk outcrop on which the rain may fall directly to feed its underground waters. It is well known that a large percentage of the water which falls on this absorbent formation sinks into it instead of flowing over the surface as is the case with clays. Moreover, the rainfall on the North Dorset downs is much heavier than in the Frome valley, and still more so in comparison with Weymouth. Hence there is an abundant supply in the region lying to the north of the borehole, and assuming the preponderance of a southerly dip, which may be taken for granted, this water in its underground passage is bound to find its way south until its progress is arrested by the pressure of water from the opposite limb of the syncline. Meanwhile it is kept down by Tertiary beds, etc., having a thickness of 280 feet. Taking the average elevation of the base of the Chalk between the Dorsetshire Gap and Bulbarrow at 650 feet *above* O.D., this may be accepted as the elevation at the outcrop in the escarpment of the North Dorset Downs. On the supposition that the Chalk is 900 feet thick beneath Bovington, this would bring the base of the Chalk to 1,010 feet *below* O.D. at the borehole. Adding these two sums together, we obtain 1,660 feet as the difference in height of the base of the Chalk between the one point and the other. This sum of 1,660 feet vertical has to be distributed over a horizontal distance of twelve miles, and this shows an incline of 1 in 38 = about 1·5°. Thus from the results of an independent calculation, we obtain precisely the same amount of dip for the northern limb of the syncline as had previously been deduced in another way. (See p. 245.)

Other Artesian Wells and Borings in Dorset.

Messrs. Eldridge, Pope, & Co.'s well at Dorchester.[1] The operations were conducted in 1880–1. The mouth of the well is on the north side of the London and South-Western Railway Station, and probably about 250 feet above O.D. The total depth bored in this case was 597 feet, wholly in the Chalk. A well was dug for 70 feet and the rest completed with 6 inch tubes. The water-level at the time work was finished stood at 45 ft. 8 in. below the surface—hence this well is 'sub-artesian' like the one at Bovington. The yield obtained was 3,000 gallons per hour. The first indications of having struck a supply of water appear to have occurred after the boring rod had passed 467 feet. Hence, in this case nearly 500 feet of Chalk was pierced ere an adequate supply of water could be obtained. According to Mr. Pope it is concluded that the base of the boring is 220 feet above the Upper Greensand, which would give 817 feet for the thickness of the Chalk at Dorchester.

The history of artesian water supply at Wimborne (Fig. 5) is an interesting one, for there the hydrostatic pressure, before the supplies had been tapped so freely as in later years, was sufficient to raise the water from the Chalk to the surface and far above it. Forty years ago (in 1867) a three-inch borehole was made at Ellis's brewery, where the Chalk is said to have been reached at a depth of 97 feet. There was such an uprise that the yard was flooded by a column of water of considerable height. It is interesting to note that in this case the water seems to have been obtained without sinking into the Chalk to any depth. This brewery is situated in the Allen Valley flat and about 60 feet above O.D.

By far the most important of the artesian wells at Wimborne are the Wimborne Waterworks and the Bournemouth Waterworks. These are situated at the north end of the town in the valley flat of the Allen, close to each other and to Warford Bridge, at an elevation of about 66 feet above O.D. As regards the Wimborne Waterworks, Mr. Fletcher[2] says that this boring was executed under his superintendence about twenty years ago. It is a 7½ inch bore, and until the Bournemouth Well was sunk within 200 or 300 yards of it the water rose in the tube-well 6 feet above the surface of the soil. This well is situated on the south-east side of Warford Bridge, and the following is the vertical section:—

		Thickness. ft.	in.	Depth. ft.	in.
Superficial	Peaty matter	6	0		
	Sub-calcareous silt	8	0	15	0
	Valley gravel and sand-rock	1	0		
Reading Beds	Plastic and variegated clay	45	0		
	Clays and sands sometimes impregnated with pyritous salts	26	0	75	0
	Flints of junction bed	4	0		
Chalk	Chalk and flints	40	0	150	0

[1] For the particulars subjoined I am indebted to Mr. Alfred Pope and to Messrs. Le Grand & Sutcliff.

[2] I have to thank Mr. Walter J. Fletcher, the County Surveyor, for many valuable information in connection with the Wimborne wells.

This is, of course, only a very generalised section, but the chief point to note is that in the Wimborne Waterworks the boring was carried down only 40 feet into the Chalk.

We now come to the consideration of the Bournemouth Waterworks, by far the most important work of the kind hitherto attempted in Dorset. In this case the vertical section shows 96 ft. 9 in. of superficial and Tertiary beds down to the Chalk—an amount of Tertiaries slightly in excess of the adjacent boring. It must not be forgotten that although these are called the "Bournemouth" Waterworks, the water is derived from the Dorset Chalk, and subsequently conveyed into the adjoining county.

The following is the vertical section:—

	Thickness.	Depth.
	ft. in.	ft. in.
Superficial Beds	7 6	7 6
Lower Tertiaries	89 6	97 0
Soft Chalk (Upper Heading)	61 6	158 6
Hard Chalk	23 0	181 6
Band of flint	0 6	182 0
Chalk to bottom of well (Lower Heading) ...	28 0	210 0
Trial boring in Chalk	45 0	255 0

Thus the "Bournemouth" Well is 210 feet, whilst the Wimborne Well is 130 feet deep.

Some of the particulars of the "Bournemouth" Waterworks may be gathered from a study of Fig. 5.[1] A 21 inch trial borehole was commenced in 1894 and finished in 1895; boring was continued to a depth of 223 feet, and it was noticed that the greatest increase in the yield of water took place shortly before arriving at that depth, the Chalk removed appearing to be much softer. The well was started in 1896, and in February, 1899, on its attaining a depth of 210 feet, a 6 inch trial boring was sunk to a further depth of 45 feet, i.e. to 255 feet from the surface. The Chalk, however, was found to be very compact at this depth, and, as there was no sign of more water at the lower level, the sinking of the well was stopped at 210 feet from the surface and the bottom concreted. The bottom of the well, therefore, is about 145 feet below O.D.

The horizontal section also serves to show the character of the Headings. The Lower Heading was first commenced in 1899 at a depth of 195 feet from the surface, and excavated on opposite sides of the main shaft. In the course of a few months a total length of about 800 feet was attained, and the flow of water was considered equal to about 1¼ million gallons per day. In July, 1899, fresh Headings (the Upper Heading) were started at a level of 155 feet from the surface in softer Chalk, much fissured; the result by November was a flow of water somewhat exceeding 1½ million gallons per day. At present I have no precise information as to the level produced by natural hydrostatic pressure in the well, but the pumping arrangements are so complete that this level is soon lowered, not only

[1] The horizontal section of the Bournemouth Waterworks at Wimborne is reproduced, by the kind permission of the Editor of *Water* and of Mr. Cripps, the engineer of the works. (See paper by Mr. Cripps in *Water*, September, 1900.)

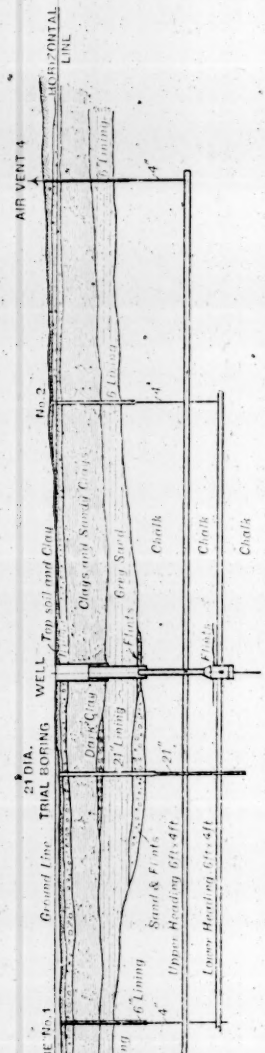


FIG. 5.—SECTION SHOWING WELL, HEADINGS, AND BORINGS, BOURNEMOUTH WATERWORKS.
Enlarged from an illustration in *Water*.

in the "Bournemouth" Well, but in all other wells, and the exhaustion is certainly felt as far as Kingston Lacy, two miles distant. The total yield of water is anticipated at 3 million gallons per day.

Attention should be drawn to the difference between the Bovington and Wimborne waters as regards their mineral contents; and, considering that they both proceed from the Chalk, this is all the more remarkable. The amount of solids obtained by evaporation in the case of the Bovington water, according to an analysis made at Devonport, is returned at 16·8 grains per gallon. Of this amount carbonate of lime contributes but little, whilst the chlorides are comparatively abundant. Hence the water must be soft. The analysis of the water of the Wimborne waterworks shows 22·19 grains per gallon, of which 14·8 grains may be expressed as carbonate of lime. Thus the Wimborne water is fairly hard, and much pains are taken to soften by artificial means the supply intended for Bournemouth.

It is evident that position with regard to existing contours is an important factor in an artesian well, and the valley of the Allen at Wimborne seems to fulfil the requirements of the case in a remarkable degree. But there is also another element in the problem, viz., the character of the Chalk encountered during operations. It has been said that permeability in the Chalk depends not so much on the nature of the Chalk itself as on the fissures by which it is traversed. This is well illustrated by the experience of the headings in the Bournemouth Waterworks at Wimborne. At the same time it is not incorrect, in a general sense, to regard the Chalk formation, with very limited exceptions, as a sponge, owing to the facility with which the water-level moves up and down, according to the amount of rainfall in those areas, such as the Hampshire and Wiltshire plateau, where the Chalk itself forms the surface. That the surface contours, and consequently the surface-flow, has some influence on the underground flow may be conceded, yet the controlling factors of the latter are in the main "the difference of pressure along the lines of flow, the varying texture of the strata traversed, and the disposition of contiguous impermeable strata."[1] In regard also to the degree of artesian pressure existing at any given spot, this may sometimes be modified by the action of springs, which, like excessive pumping, tend to bleed the underground arteries, and thus lower the general water-level for considerable distances.

III.—On some Fossil Reptilian Bones from the State of Rio Grande do Sul, Brazil.[2]

By Arthur Smith Woodward, LL.D., F.R.S.

A FEW fossil reptilian bones discovered by Dr. Jango Fischer in 1902 at Santa Maria da Bocca do Monte (Serrito) in the Rio Grande do Sul, which have been submitted to me by Dr. H. von

[1] Baldwin-Wiseman, on the "Motion of Sub-surface Water": Quart. Journ. Geol. Soc., vol. lxiii, p. 98. A sketch-map of sub-surface water-levels in the Chalk of Dorset, Wiltshire, and Hampshire is appended to this paper.

[2] Reprinted from Revista do Museu Paulista, vol. vii (1907), pp. 46–57. See also abstract in Rep. Brit. Assoc., 1903 (1904), p. 663.

Ihering (San Paulo Museum) are of much interest. They not only appear to determine the geological age of the formation from which they were obtained, but also foreshadow the discovery of an early Mesozoic South American land fauna, which has long been expected.

They comprise three nearly complete vertebral centra and a fragment of a fourth centrum, with one digit of four phalanges and a separate ungual phalange. The bones were found together under such circumstances that they probably all belong to one individual.

The vertebral centra are remarkable for (i) their very short antero-posterior extent, (ii) the deeply ovoid shape of their articular ends, and (iii) the considerable constriction of their sides.

The best-preserved specimen (Figs. 1, 1A) is evidently not much crushed, and shows that both the articular ends are slightly concave.

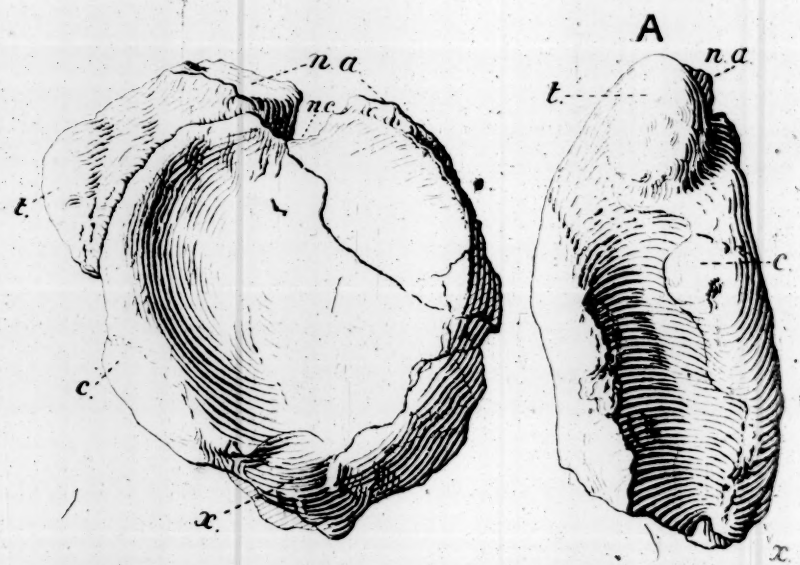


FIG. 1.—Cervical vertebra, anterior and right lateral (A) views. *c.* articulation for capitulum of rib; *n.a.* base of neural arch; *n.c.* neural canal; *t.* articulation for capitulum of rib; *x.* facette for intercentrum. $\frac{2}{3}$ nat. size.

It also exhibits the characteristic constriction of the sides, with the prominent anterior rim, which bears a deeply ovoid, rounded boss (*c.*) for the articulation of the capitulum of a double-headed rib. The lower part of the same rim is bevelled in such a way (*x.*) as to suggest that an intervertebral wedge-bone may originally have been present. The neural canal (*n.c.*) produces a shallow groove in the centrum. The base of the neural arch (*n.a.*) still remains, and proves that it is firmly fused with the centrum, not merely articulated by suture. This arch extends from end to end of the centrum, but leaves a slight rim of the latter projecting in front. Its lateral portion is produced somewhat downwards and ends in a deeply ovoid, rounded

boss (*t.*), for the articulation of the tuberculum of the rib already mentioned. It is thus evident that the rib must have been stout, deep, and antero-posteriorly compressed at its double-headed upper end.

One of the most imperfect vertebral centra is essentially identical with that just described, showing a similar rib-articulation and a space for a wedge-bone. The other good specimen (Figs. 2, 2A), however, is somewhat smaller, with no clear indication of a facette on the centrum either for a rib or for a wedge-bone. Its articular ends are slightly concave. The base of its neural arch seems to show that it agrees with that of the other vertebra in being fused with the centrum, while the neural canal similarly forms a shallow groove.

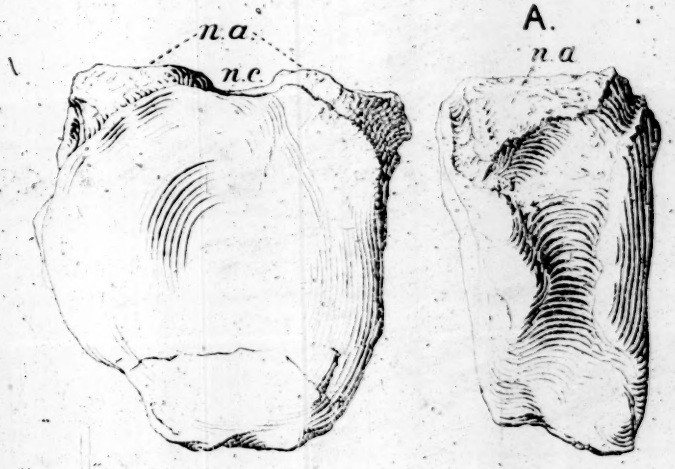


FIG. 2.—Dorsal vertebra, anterior and right lateral (A) aspects. ⅔ nat. size.

The first type of vertebra (Fig. 1) obviously belongs to the cervical, while the second (Fig. 2) must be referred to the dorsal region. If, therefore, these specimens represent one and the same individual, the neck must have been comparatively large and stout, doubtless for the support of a heavy head.

The digit of four phalanges (Figs. 3, 3A) is interesting on account of the shape of the claw. The ungual phalange is laterally compressed and unsymmetrical, the left or less deep side being flattened or almost hollowed, while the other side is slightly convex. The bone is not marked by any lateral groove, but its lower face is considerably excavated and has a sharp rim. The two phalanges following the ungual are short and broad, and much constricted round the middle. The next bone, which perhaps admits of more than one interpretation, is more elongated than those just mentioned, but not so long as the ungual. It seems to be displaced in the fossil, being, in fact, accidentally turned on its long axis to an extent of 45°, so that its imperfect right side only is seen in Fig. 3, its left side in Fig. 3A. If this interpretation be correct the bone is another phalange, with the saddle-shaped proximal articular face somewhat deeper than wide.

The detached ungual phalange (Figs. 4, 4A, 4B) resembles the corresponding bone of the digit just described in the concavity of its lower face (Fig. 4A) and in its lack of bilateral symmetry; but it is relatively large and expanded. Its articular face (Fig. 4B) is oblique and much deeper than broad; its slightly convex side (Fig. 4) is excessively large, owing to the expansion of the thin, rounded, distal border; while its flattened left side (Fig. 4A) is a comparatively small triangular area.

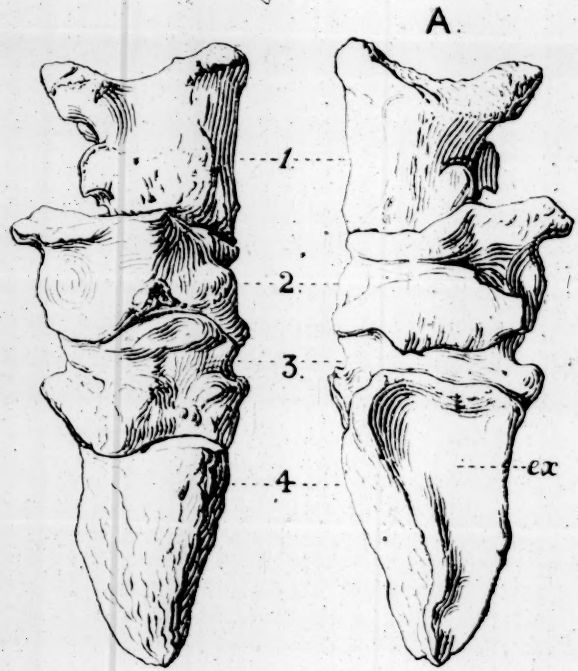


FIG. 3.—Digit with four phalanges (1–4), upper and lower (A) views. *ex*, excavation of lower face of ungual phalange. $\frac{2}{3}$ nat. size.

The two ungual phalanges evidently belong to one and the same foot, which must have had obliquely-curved digits. If constructed as in the Sauropodous Dinosaurs this foot would be of the left side, the large claw belonging to digit I, while the series of four phalanges would probably represent digit III.

It is difficult to determine the affinities of a reptile known only by remains as fragmentary as those now described. It is evident, however, that the bones are those of a land-reptile: and the characters of the vertebræ suggest that they belong either to an Anomodont or to a primitive Dinosaur. The fact that the dorsal vertebral centrum shows no clear mark of an articular facette for the rib seems to prevent its reference to an Anomodont; while the shape and characters of the cervical vertebra are so closely similar to those of a corresponding vertebra from the Karoo Formation of South

Africa ascribed to the Dinosaurian *Euskelesaurus* by Seeley[1] that the new Brazilian reptile is probably allied to the latter. The striking inequality in the size of the obliquely-curved toes is also less suggestive of an Anomodont than of a Dinosaur; and although it is possible that some of the larger Anomodonts had a digital formula like that of lizards and crocodiles, this was not the normal condition, and a digit with four phalanges is more likely to have belonged to a Dinosaur than to a member of the more primitive order.

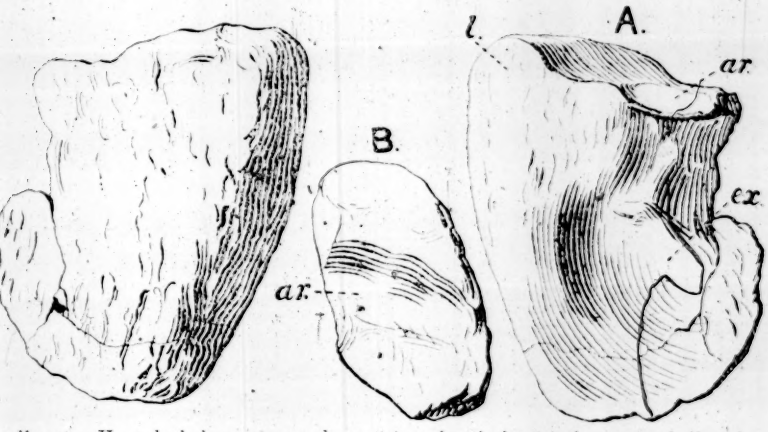


FIG. 4.—Ungual phalange, upper, lower (A), and articular (B) views. *ar.* hollowed articular face; *l.* flattened inner face; *ex.* excavation of lower face. ⅔ nat. size.

I therefore refer the new Brazilian fossils to a short-necked Dinosaur allied to *Euskelesaurus*, and I propose to name this reptile *Scaphonyx* in allusion to the unique inferior excavation of the ungual phalanges. The species may be known as *Scaphonyx Fischeri*.

If this determination be correct, the rocks in which the bones were found may be regarded as of Triassic age. *Scaphonyx* is also to be considered as the first fossil land-reptile discovered in South America which clearly belongs to the fauna of 'Gondwana Land.'

Postscript, April, 1908.—The preceding paper was written in 1904, when Professor Seeley's determination of the cervical vertebra of *Euskelesaurus* had not been questioned. Since that time Baron F. von Huene (Palæont. Abhandl., N.S., vol. viii, 1906, p. 123) has expressed the opinion that the vertebra in question does not belong to a Dinosaur, but to an Anomodont; while Dr. R. Broom has described similar vertebræ from the Upper Beaufort Beds of the Karoo Formation under the new generic name of *Erythrosuchus* (Ann. S. African Mus., vol. v, 1906, p. 193). According to Dr. Broom's description this reptile is not a Dinosaur, but exhibits many resemblances both to Belodonts and to Anomodonts. From new specimens submitted to me by Dr. I. C. White, I am now of opinion that *Scaphonyx* is an Anomodont.—A. S. W.

[1] H. G. Seeley, "On *Euskelesaurus Browni* (Huxley)"; Ann. Mag. Nat. Hist. (6), vol. xiv (1894), p. 339, fig. 7. Original vertebra now in the British Museum.

IV.—Sedgwick Museum Notes.

Notes on some Fossils from Nepal.

By F. R. Cowper Reed, M.A., F.G.S.

Amongst the foreign Jurassic fossils in the Sedgwick Museum, acquired or presented many years ago and but rarely referred to, some specimens labelled "Himalayan Lias" recently came under my notice. They were marked as having been presented by Mr. J. Leckenby in 1872, and had been carefully kept together with the old label, giving the locality and history. Some of them had at some subsequent date been mounted and identified with well-known European Liassic species.

The old label accompanying them bore the following inscription:—"Ammonites from the Salagrammi River near Mooktinath, 18,000 ft. above the level of the sea. Presented to me by Dr. Wallich. April, 1822. [Signed] T. F. C." The whole label is in the same hand-writing as the initials T. F. C., and Mr. Daydon Jackson, General Secretary of the Linnean Society, to whose kind assistance I owe much information about Dr. Wallich, considers it almost certain that the person thus signing himself was Major-General Thomas Frederick Colby, R.E., F.R.S., F.G.S. (1784–1852), Director of the Ordnance Survey, after whom Portlock[1] named the well-known trilobite *Remopleurides Colbii*, and who was actively interested in geology in his time. The present Director of the Geological Survey of India has also made to me the same suggestion as to the identity of T. F. C.

Dr. Wallich (1786–1854), whose full name was Nathan Wolff Wallich, though during his scientific career he called himself simply Nathaniel Wallich, was born in Copenhagen in 1786, went out to India in the Danish service in 1807, and entered the service of the N.E.I. Company in 1813, becoming Superintendent of the Calcutta Botanical Garden in 1815, and retaining that post till his retirement in 1846. He travelled extensively in India and Nepal, and contributed various papers to the Transactions of the Asiatic Society of Bengal, dealing with the plants he discovered. His name first appears in the list of members of that Society in the year 1820, and on several occasions he presented fossils to the Society's collection, but none apparently from Nepal, though many plants were collected and described by him from that country. The type-set of his great Indian collections is in the possession of the Linnean Society, but the geographical indications of the localities are stated to be of the scantiest. It is therefore of especial interest that the precise locality where these fossils were found was recorded at the time on the label accompanying them.

Mooktinath or Muktinath is situated on the upper part of the river Kali or Buria Gandak, on the north side of the main Himalayan range and south of Lob Mantang; it is also known as Thochumigarsa, and has the altitude 13,100 feet against it, according to a recent (1891) official map of India, published in Calcutta. The apparent discrepancy

[1] Portlock: Geol. Rep. Londond., p. 256.

in the name of the river is explained in an old paper on the Ancient Geography of India by Lieut.-Col. F. Wilford (Trans. Asiatic Soc. Bengal, vol. xiv, 1822, p. 415), who states that the alternative name for the Gandaca (= Gandak) is the Sallagramma, and he adds the valuable and illuminating remark that the river is so called because of the stone of that name found in its bed. This is of importance because the ammonite-bearing concretions of precisely similar character to those in this Wallich collection are known throughout India as Salagrams, and are used as charms. Thus Everest[1] figured an ammonite of this type from the Himalayas in 1833 with the note that such are the Salagrams of the Hindoo temples; and Mr. H. J. Colebrooke[2] presented to the Geological Society in 1818 "argillaceous nodules containing Ammonites and called Salagrams, worshipped by the Hindoos." Mr. G. H. Tipper, of the Indian Geological Survey, on seeing Wallich's ammonites in the Sedgwick Museum at once recognised them as being typical Salagrams. Dr. T. H. Holland, however, informs me that some so-called Salagrams are only small rounded boulders of quartzite. In Blanford's[3] figures and descriptions of the Cephalopods from Nepal in General Hardwicke's collection no precise localities are given, but the word 'Sulgranees' appears on plate C in J. E. Gray's work,[4] where some of these fossils are figured, and Blanford[5] has recently suggested that it is probably a corruption of the word 'Saligram.' The latter has also expressed the view that "it is very doubtful if any of the Ammonites represented in the 'Illustrations' came originally from Nepal at all; it is more probable that they came from further west, from the region whence Ammonites have been supplied to India in all probability for ages. It is certain that there has long been an importation of small Ammonites into India from the Tibetan side of the Himalayas, chiefly from the Spiti district, N.N.E. of Simla, or from the neighbourhood of the Niti pass, north of Kumaun." It was previously stated in Blanford & Oldham's Geology of India (2nd ed., 1893, p. 229), that Jurassic rocks were known to occur north of Nepal, characteristic fossils having been brought by traders, but no locality in Nepal itself is given, so that it appears doubtful if any recorded occurrence in Nepal with the precise locality has previously been published. It must not, however, be overlooked that Oppel[6] refers to a specimen of *Ammonites sabineanus*, Oppel, in a black nodule from the river 'Gundock' (? = Gandak), which had been kept in the collection of the Jardin des Plantes in Paris since 1825; this fossil may possibly have been obtained from the same spot as Wallich's specimens, particularly as the mode of occurrence suggests a Salagram, and as the same species is most probably represented

[1] Everest, Himalayan Fossils, Asiatic Researches: Trans. Asiat. Soc. Bengal, vol. xviii (1833), pl. i, fig. 3.
[2] Trans. Geol. Soc. London, vol. v (1821), p. 643.
[3] Blanford: Journ. Asiat. Soc. Bengal, vol. xxxii (1863), p. 124.
[4] J. E. Gray: Illustrations of Indian Zoology; chiefly selected from the collection of Major-General Hardwicke (published 1830–2), plate C (no description).
[5] Blanford: Proc. Malac. Soc., vol. v, No. 6 (October, 1903), p. 345. Cricks: Geol. Mag., Dec. V, Vol. I (1904), p. 62.
[6] Oppel: Paläontologische Mittheilungen, vol. iv (1863), p. 302.

amongst ours from Muktinath; moreover, it is one of those described by Oppel as associated in other parts of the Himalayas with species (*A. frequens*, etc.) allied to or identical with ours. One of the Ammonites from Nepal, described by Gray in his above-mentioned work, was dedicated to Dr. Wallich (*A. Wallichi*, pl. C, fig. 3); the specimen[1] is in the British Museum collection, and the same species has been recognised by Mr. Crick amongst our fossils from Muktinath. To Mr. Crick I am much indebted for valuable help in the identifications.

In the Sedgwick Museum Collection from Muktinath there are in all sixty-three specimens, the majority of which are ammonites and belemnites: and from a preliminary examination of this material it seemed evident to me that they were wrongly referred to the Lias. Having Salter & Blanford's work on the "Palæontology of Niti" (Calcutta, 1865) at hand, a comparison with the illustrations of Jurassic fossils in that book naturally suggested itself, and then with Oppel's figures of Himalayan Cephalopods in his "Paläontologische Mittheilungen" (vol. iv, 1863). Finally Uhlig's uncompleted memoir in the *Palæontologia Indica* on the fauna of the Spiti Shales was consulted. From these investigations it became obvious that many of the Cephalopods were closely similar to, if not identical with, previously described Upper Jurassic forms from the Himalayas. Mr. G. H. Tipper (of the Geological Survey of India), on seeing the specimens, at once recognised their mode of preservation and lithological characters to be unquestionably identical with that of fossils from the Spiti Shales. At the British Museum I was subsequently enabled with Mr. Crick's kind assistance to make a direct comparison of them with Blanford's type-specimens from Niti, and my views as to the stratigraphical horizon and affinities of the fossils were confirmed by Mr. Crick, who is also of the opinion that many of the species are identical and others closely allied.

Until Professor Uhlig has completed his researches on the fauna of the Spiti Shales it would be undesirable to attempt a detailed description of this interesting material, but so far as the works of the above quoted authors take us the following genera and species can be recognised:—

Belemnites cf. *sulcatus*, Miller.

The large stout form figured by Blanford under this name (Palæont. Niti, p. 76, pl. x, figs. 1–7) and the large phragmocones precisely correspond with some of our specimens, but there is also the more slender form named *B. Gerardi* by Oppel, which Blanford considered a synonym of the present species (Crick, GEOL. MAG., Dec. V, Vol. I, 1904, p. 64). Boehm's work on the allied species of *Belemnites* from the Moluccas suggests that more than one species is included under this name. The figures given by Everest[2] of a belemnite from the

[1] Crick: op. cit., pp. 62, 63; and Proc. Malac. Soc., vol. v, No. 4 (April, 1903), p. 286.

[2] Everest, Himalayan Fossils, Asiatic Researches: Trans. Asiat. Soc. Bengal, vol. xviii (1835), p. 108, pl. i, figs. 16, 17.

Himalayas represents a form similar to Blanford's *B. sulcatus*. In Somaliland a closely allied form has been found (Crick, Geol. Mag., Dec. IV, Vol. III, 1896, p. 296).

Hoplites Wallichii, Gray.

One specimen in our collection may be without doubt identified with this species,[1] and especially resembles one of the specimens figured by Blanford (op. cit., pl. xv, figs. 1*a–c*).

Perisphinctes cf. *biplex*, Sowerby.

The species from Niti which Blanford (op. cit., p. 79, pl. xi, figs. 4*a–c*; pl. xii, figs. 1*a–c*) referred to Sowerby's *A. biplex*, is the most abundant ammonite in the Muktinath collection, but mostly occurs only as external casts, similar to that figured by Everest,[2] and mentioned by him as being the Salagrams of Hindoo temples. The true specific reference of this form must for the present be left uncertain.

Perisphinctes cf. *torquatus*, Sowerby.

Mr. Crick pointed out to me that several of our specimens are indistinguishable from the form described by Blanford (op. cit., p. 80) as *Am. torquatus*, Sowerby, of which the specimens are in the British Museum.

Perisphinctes aff. *frequens*, Oppel.

A large, nearly perfect ammonite, measuring between 15 and 16 c.c. in diameter, appears to be closely allied, if not identical, with Oppel's species, *A. frequens*, from the Himalayas.[3] A smaller specimen may perhaps belong to the same species, or be a variety. The larger one appears to be in rather a different state of preservation and not to have come out of a nodule.

Perisphinctes cf. *sabineanus*, Oppel.

One small specimen, measuring about 40 mm. in diameter, may be compared with Oppel's *A. sabineanus*[4] from the Himalayas.[4] It is not in quite the same state of preservation as the other ammonites, more resembling in this respect the large example of *P.* aff. *frequens*.

Oppelia (*Streblites*) cf. *Griesbachi*, Uhlig.

The external impression of one side of an *Oppelia* may be compared with Uhlig's *O. Griesbachi*[5] from the Spiti Shales; the serrated keel and ornamentation of the whorls, as well as the general shape and characters of the shell, are apparently identical.

[1] Crick, op. cit., p. 118.
[2] Everest, op. cit., pl. i, fig. 3.
[3] Oppel, op. cit., p. 295, t. 87; Siemeradzki, Mon. Ammn. *Perisphinctes*, Palæontographica, Bd. xlv, Lief. 3 (1898), p. 237.
[4] Oppel, op. cit., p. 288, t. 82, figs. 1*a–c*, 2*a*, *b*; Siemeradzki, op. cit., p. 170, pl. xx, fig. 2.
[5] Uhlig, Fauna of the Spiti Shales, Palæont. Indica, ser. xv, vol. iv (1903), p. 47, pl. v, figs. 2*a–g*, 3*a–c*, 4*a*, *b*; pl. vi, figs. 1*a–c*, 2*a–d*, 4*a–d*, 5*a*, *c*.

Parallelodon egertonianus (Stoliczka).

The internal cast of a large lamellibranch possesses the shape and characters of hinge and teeth of the well-known *P. egertonianus* of the Spiti Shales.[1] This species has also been found in Somaliland.[2]

Nucula sp.

One imperfect internal cast of a species of *Nucula* occurs in the collection adhering to the outside of a nodule containing an example of *Peri. biplex*. The hinge-line with its minute transverse teeth is visible, but the specimen is too imperfect for further description.

Rhynchonella cf. *variabilis*, Schlotheim.

Only the pedicle valve of one example of a *Rhynchonella* is present, and it is likewise attached to the exterior of a geode. The form from Niti referred by Blanford[3] to *Rhynch. variabilis*, Schlotheim, is apparently identical.

Fossils from Nepal are so rare and difficult to obtain that the above-mentioned are of special interest, and stratigraphically fill up a gap in our knowledge as to the eastward extension of the Spiti Shale fauna.

The extension of the Spiti Shales eastwards from Nepal has been proved by their discovery[4] in Central Tibet, near the Kongra La and Kampa dzong, in about 28° N. lat. and 88° E. long., during the last expedition into Tibet. But Boehm's[5] researches in the Sula Islands have carried the distribution of the distinctive fauna of these beds still further to the east, for on the south coast of the islands of Taliabu and Mangoli, between 1° and 2° S. lat. and 124° and 126° E. long., some of the typical species (*Hoplites Wallichi*, Gray, and *Phylloceras strigile*, Blanf.), with others closely allied to Himalayan forms (e.g. *Belemnites alfuricus*, Boehm, aff. *P. Gerardi*, Oppel), have been found; and even in Dutch New Guinea, at 2° 22′ S. lat. and 139° 50′ E. long., Boehm (op. cit., 1907, footnote on p. 118) states that representative ammonites of the same fauna occur, and probably also on the Strickland River in 142° E. long., in British territory. Rothpletz[7] had previously described and figured *Belemnites Gerardi* from the island of Rotti in about 11° S. lat. and 123° E. long. Several stratigraphical subdivisions of the Spiti Shales were recognised by Diener[8] in the Himalayas, and Boehm likewise maintains that in the Moluccas also they include horizons from the Oxford Clay upwards to the passage beds between the Jurassic and the Cretaceous.

[1] Stoliczka: Mem. Geol. Surv. India, vol. v (1866), pt. 1, p. 89, pl. viii, fig. 7.

[2] R. B. Newton: Geol. Mag., Dec. IV, Vol. III (1896), p. 294.

[3] Blanford & Salter: Palæont. Niti, p. 101, pl. xxi, figs. 7*a–c*.

[4] Hayden: Geol. of Provinces of Tsang and Ü in Central Tibet, pp. 31–34 (Mem. Geol. Surv. India, vol. xxxvi, pt. 2, 1907).

[5] Boehm: Beitr. z. Geol. Niederland. Indien, i, pp. 1–46, pls. i–vii (Palæontographica, Suppl. iv, Lief. 1, 1904); pp. 59–120, pls. ix–xxxi (Palæontographica, Suppl. iv, Lief. 2, 1907).

[6] Boehm: Neues Jahrb. f. Miner., Beil. Bd. xxii (1906), pp. 393–396, and references.

[7] Rothpletz: Die Perm-, Trias-, und Jura-Formation auf Timor und Rotti, p. 104, t. xiii, figs. 6–8, 10, 12 (Palæontographica, Bd. xxxix, Lief. 2, 1892).

[8] Diener: Denkschr. Kais. Akad. Wiss. Wien, Math. Natur. Kl., Bd. lxii (1895), pp. 582–588.

Two other specimens in Wallich's collection certainly come from a different horizon, and their mode of preservation is not the same. One is the imperfect valve of a species of *Halobia* comparable with *H. charlyana*, Mojs., which has been recorded from the Trias of Rotti and Sumatra;[1] it occurs in a black shaly limestone. The other is the internal cast of an ammonoid almost wholly replaced by crystalline calcite, but showing in one part the suture-line, the characters of which, so far as they are visible, suggest that it may be referred to the genus *Ptychites*, and the shape of the shell much resembles that of *Pt. rugifer*; Oppel. It is evident, therefore, that the Trias also occurs near Muktinath.

V.—Preliminary Note on some Unrecorded Exposures of the Quartz-Felsite in North-West Carnarvonshire.

By A. B. Badger, M.A., B.Sc.

During an investigation of the rocks of North-West Carnarvonshire older than the Llanberis Slates, the detailed results of which I hope soon to publish, I have discovered certain exposures of quartz-felsite which are not marked as such on the maps of the Geological Ordnance Survey, nor have been described, as far as I know, by other observers.

Reference to maps 75 N.W., 78 S.W., and 78 S.E. of the 1 inch Geological Survey, or to Sheet 7 of the Geological Index Map, will show that in the area stretching from Bangor and Bethesda on the north-east to the Vale of Nantle on the south-west two bands of quartz-felsite are marked, the one extending from Bangor to Carnarvon, the other from the Penrhyn Slate Quarry through Llanberis to the village of Llanllyfni. As is well known, these rocks have been variously regarded as of Pre-Cambrian, early Cambrian, and Post-Cambrian age.

The exposures which I desire to record lie to the west of the eastern band of felsite, and proceeding generally from north-east to south-west occur at the localities named below.

Locality.	1 Inch Geological Map.	6 Inch Ordnance Map.
(1) Farm of Ty'n y caeau	78 S.E.	Carnarvonshire, XII. N.W.
(2) Gwirtai River, near Bontnewydd...	78 S.W.	,, XV. S.E.
(3) Near Gadlys Farm	,,	,, ,,
(4) Near Llanwnda Railway Station ...	,,	,, ,,
(5) Glynllitŏn Park	75 N.W.	,, XX. N.E.
(6) Brynmawr Farm	,,	,, XX. S.E.
(7) East of Llanllyfni	,,	,, XX. S.E. and XXI. S.W.

(1) *Ty'n y caeau Farm.*—This locality lies about 2½ miles to the north-west of Penrhyn Quarry, the most northerly point at which the eastern band of quartz-felsite has been found hitherto. The outcrop is about 330 yards in length and 50 yards in breadth at its widest. It strikes 60° east of north and forms a low ridge. On the north-west

[1] Volz: Zeitschr. deut. geol. Gesell., vol. li (1899), p. 35, t. i, figs. 12, 13.

it is covered by conglomerates and grits, while to the south-east there is low-lying swampy ground, the boundary on this side probably being a fault. The rock is grey in colour, and at the south-western end of the exposure near the farm buildings flow-structure is well displayed on the weathered surfaces; elsewhere, however, this is not so apparent. The microscopical characters are generally those of the Cwmyglo rock, but specimens from the eastern side do not show flow-structure, and are much decomposed and brecciated.

There do not appear to be any other exposures of the quartz-felsite between this point and those so well known near the north-west end of Llyn Padarn, some five miles away.

(2) *Gwirfai River, near Bontnewydd.*—The small village of Bontnewydd is about two miles south of Carnarvon. A quarter of a mile to the east the ground rises into the hilly slopes which lie in front of Mynydd Mawr and Moel Eilio. Debouching from a somewhat narrow channel, cut through this higher ground, the Gwirfai River flows eastward from Lake Cwellyn through Bontnewydd to Carnarvon Bay. The Geological Survey Map shows the river as traversing the quartz-felsite from Bettws Garmon to within a mile and a half of Bontnewydd, and for the next mile and a quarter as traversing Cambrian grits and conglomerates. Stratified rocks, however, do not occur for all this distance; they crop out about two-thirds of a mile west of the quartz-felsite, and from this point extend for 300 yards to the west. Again, just at the opening of the gorge grits and conglomerates are found, but for some 600 yards east of that opening the sides of the gorge are formed of quartz-felsite. The latter rock shows numerous phenocrysts of quartz and felspar, the first-named mineral being much cracked.

It may be remarked in passing that the stratified rocks which are found at the mouth of the gorge lie directly on the felsite and comprise grits of quartz and pink felspar, and very coarse conglomerates which have a remarkable resemblance to those so well known at Llanddeiniolen.

(3) *Gadlys Farm.*—In a lane leading from the main road a little north of Llanwnda Railway Station there is a small opening in which pink quartz-felsite is exposed.

(4) *Llanwnda Station.*—Half a mile to the south-west of the last exposure, quartz-felsite is again exposed in a few patches on the eastern bank of the railway cutting some 100 yards south of the station.

(5) *Glynllifon.*—The next series of exposures occurs in Glynllifon Park, the residence of the Hon. Frederick Wynn, owing to whose kindness it is that I have been able to examine this locality. The Geological Ordnance Map marks the eastern half of Glynllifon as "altered Cambrian Sandstone," probably because the surveyors mistook the quartz-felsite noted below as exposed in Coed Penbrynmawr for a metamorphic rock. The other exposures, however, to which I refer, occur in parts of Glynllifon marked on the map as unaltered Cambrian Grits and Conglomerates.

Most of the exposures of the igneous rock are found in or near the narrow valley of the little stream called the Afon Llifon, which here extends from the so-called 'East' Lodge on the north for a distance

of about half a mile to near Glynllifon House on the south-west. The width of the outcrop so exposed is only some 150 yards, but I am informed that the rock was found in excavations for cellars at the back of the house, which shows that it extends at least 300 yards further westwards. At one exposure it is seen that grits coarse and fine lie directly on the felsite; these rocks are apparently continuous for a mile or more to the west.

At the quarry called Gallt-y-Prif a narrow band of the quartz-felsite is found among the grits, brought in apparently by faults.

The greater part of Glynllifon is covered with drift, and there are no other exposures of the felsite or of the so-called Cambrian Grits, either to the east or south of those just described, except in the locality first mentioned. This is near the southern boundary wall, in the wood named on the 6 inch map, Coed Penbrynmawr. Here in several openings the quartz-felsite is again exposed. The quartz-felsite of Glynllifon varies from cream-coloured to grey and reddish-grey in colour, and contains many quartz phenocrysts much corroded and broken; in places it is much cleaved, in others it is massive.

(6) *Brynmawr Farm.*—A few yards south of the southern boundary wall of Glynllifon, continuing the line of the exposures in Coed Penbrynmawr, there is a small opening where the quartz-felsite is again to be found, and further on for half a mile to the south-west there are other exposures in the somewhat steeply sloping ground on which stands the farm called Brynmawr. Judging from the Survey Maps these rocks were considered to be metamorphosed Cambrian Sandstones.

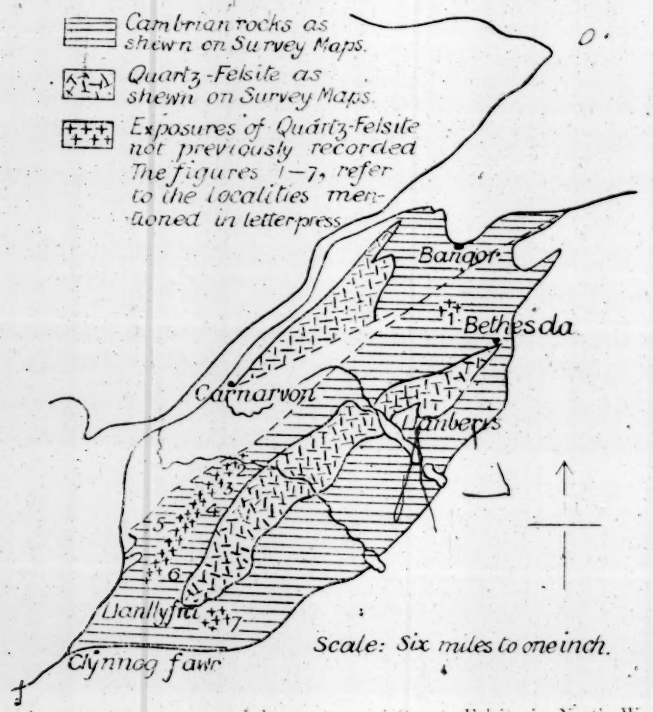
(7) *Llanllyfni.*—On Sheet 75 N.W. of the 1 inch Geological Ordnance Map, the boundary between the quartz-felsite and the adjoining rocks, the so-called Cambrian Slates and Grits, is drawn as passing from Nantle Railway Station south-westwards to a point just north of the village of Llanllyfni. The stratified rocks are marked as forming a continuous band, a mile or more wide, wrapping round the felsite. As a matter of fact much of this area is formed of the felsite faulted against the slates and grits. It is exhibited at the following places, so-named on the 6 inch ordnance map or so known locally: Penglog,[1] Tyddyn Agnes, Gwynfaes, Taldrwst isaf, Taldrwst ganol, Taldrwst uchaf, Singrig Quarry, and Tanyrallt Quarry. The area over which the rock is exposed is rather more than half a mile from south-west to north-east and about one-third of a mile from north-west to south-east. Probably the felsite is present over a still larger area, but deep drift obscures the outcrops.

In this locality the felsite is extremely schistose, the felspars having been in most cases completely broken down. In some places the quartz grains are very numerous, while elsewhere they are few and small.

The surface of the ground between the exposures numbered (2) to (6) inclusive is largely formed by Drift, so that one cannot actually trace the course of the quartz-felsite from exposure to exposure by means of the surface features. There cannot, however, be any reasonable doubt

[1] This is probably the locality just referred to by J. H. Blake, Q.J.G.S., xlix, p. 463.

but that a continuous band of that rock does extend for a distance of four and a half miles along a line running from Bontnewydd on the north-north-east to Brynmawr Farm on the south-south-west, and that such an outcrop should be marked on the Survey geological maps instead of the rocks at present represented on them. Whether this middle band of felsite is continuous with the eastern band, or not, or whether the Survey maps are correct in showing the so-called Cambrian Grits as extending continuously from the Gwirfai River to the south-west, it appears at present impossible to determine, for the relationships of these older rocks are completely obscured by the thick covering of glacial deposits.


Cambrian rocks as shewn on Survey Maps.
Quartz-Felsite as shewn on Survey Maps.
Exposures of Quartz-Felsite not previously recorded. The figures 1–7, refer to the localities mentioned in letterpress.
Bangor
Bethesda
Carnarvon
Llanberis
Llanllyfni
Clynnog fawr
Scale: Six miles to one inch.

Sketch-map of some unrecorded exposures of Quartz-Felsite in North-West Carnarvonshire.

VI.—Note on the Geology of the Falkland Islands.

By J. Halle, Geologist to the Swedish Magellanic Expedition.

(Communicated by Dr. Carl Skottsberg, Director of the Expedition.)

THE Swedish Magellanic Expedition spent some time in the Falkland Islands before proceeding to Tierra del Fuego, where important work is being carried on. The writer utilised his stay in the Falklands to study the geology and collect fossils. The following is a brief note of the work there.

The Devonian formation, which constitutes the larger part of the islands, was carefully surveyed, and fossils discovered in several new localities. The stratigraphical and tectonic conditions, on the West Island especially, proved to be of much interest. My most important task, however, was to solve the question of the supposed occurrence of Permo-Carboniferous layers of the Gondwana type. Some fragmentary plant-fossils, collected in 1902 during the Swedish Antarctic expedition, were described by Professor Nathorst in Stockholm under the name of *Phyllotheca* sp., and compared with a species from the *Glossopteris* flora, but owing to the fragmentary condition of the specimens their determination remained doubtful. I have now been able to settle the question. Fossils, principally leaves of *Glossopteris*, occur in many places, and it is evident that the whole southern part of East Falkland south of Wickham Heights belongs to the Gondwana system. At the base of the *Glossopteris* series I discovered a Boulder-clay formation containing blocks of stone apparently of Glacial origin, which undoubtedly corresponds to the well-known moraines from other parts of Gondwanaland.

Of more recent formations, an interesting Forest-bed, discovered on West Point Island by Mr. A. S. Felton, was made an object of special investigation. The bed, which contains great quantities of large trunks, is covered by old 'flowing soil,' and is probably of Pre-glacial age. After having been worked out, my collections will give important information as to the phyto-geographical and climatological conditions of these islands during the early Quaternary period. I have also paid attention to the other Pleistocene deposits, as well as to the question of changes of level, supposed to have occurred in the latest period. The result of these researches cannot be communicated until the observations and collections have been thoroughly studied.

VII.—An Analysis of London Clay.

By J. H. B. Jenkins, F.C.S.

THE sample analysed was derived from a well-boring made at East Ham by Messrs. C. Isler & Co., who gave the following table of the strata passed through:—

		Thickness.		Depth.	
		ft.	in.	ft.	in.
Soil	Mould	3	0	3	0
River Gravel	Ballast	14	0	17	0
London Clay	London Clay	59	0	76	0
	Sand, Shells, and Pebbles	10	0	86	0
Woolwich Beds and Thanet Sand.	Blue Clay and Shells	10	0	96	0
	Mottled Sand	6	0	102	0
	Sandstone	5	0	107	0
	Gray Sand	16	0	123	0
	Live Gray Sand	30	0	153	0
	Dead Gray Sand Loam	26	6	179	6
	Green Coated Flints	0	6	180	0
	Chalk and Flints	120	0	300	0

The sample was taken from the stratum of clay between 17 and 76 feet below the surface.

It was a wet, stiff clay, of dark-gray colour. On heating to 120° C. it lost 20·1 per cent., and there was a further loss of 6·3 per cent. on ignition.

The residue was of brick-red colour, and on analysis gave the following results:—

Silica	67·9
Alumina	18·3
Ferric Oxide	8·7
Lime	1·3
Magnesia	1·2
Potash...	1·6
Soda	1·4
	100·4

VIII.—Mottled Foraminiferous Limestone in West and North Lancashire.

By J. Wilfrid Jackson (Manchester Museum).

EARLY in 1904, whilst spending a holiday at Silverdale, near Carnforth, I noticed at the roadside near the Silverdale Hotel several heaps of a peculiar mottled limestone which was being broken up for road-metal. The resemblance to specimens I had seen from Derbyshire struck me at once, and I was not long in locating the quarry from which the material had been derived. The exposure of the rock is situated near the turn of an old cart track leading from Silverdale Green to Burton Well. When I visited the place there was a section visible of about 12 to 14 feet long and 2 to 3 feet deep. On the top was a thin layer of surface soil with vegetation on it. The floor of the quarry was also of the same mottled limestone. The strata here and in the immediate neighbourhood are rolling with a general dip of 10° E.

Whilst traversing the district again in 1905 I came across another small exposure of this mottled limestone in a small roadside quarry near Woodwell, about three-quarters of a mile south-west of that at Burton Well. Here about the same depth was exposed, the strata dipping slightly to the S.E. I cannot say definitely, as yet, whether these two sections are exposures of the same bed, but it is highly probable.

Quite recently I came across a small slab of mottled limestone at the Chadwick Museum, Bolton, which the curator, Mr. T. Midgley, informed me had been obtained from Grange-over-Sands by a Mr. H. Wright. It is part of a large slab found under some feet of Boulder-clay on the Eden Park Estate, and both pieces are beautifully glaciated. The direction of the scratches as the block lay undisturbed was noticed to be from north to south. I also possess a specimen and slides of mottled limestone from the Boulder-clay near Burscough Bridge, South Lancashire, collected by a friend of mine, which is highly foraminiferous, and agrees closely with the Silverdale specimens.

The Silverdale specimens partake of exactly the same character as those described by Messrs. Barnes and Holroyd from Derbyshire[1]

[1] "On the Mottled Carboniferous Limestone of Derbyshire": Trans. Manch. Geol. Soc., vol. xxvi, p. 561.

The matrix is light-coloured and fine-grained, with irregularly shaped patches (? nodules) of a fine-grained dark-coloured limestone. The patches have no definite shape, being mostly very uneven in size, some of them being long cylindrical bodies with irregular contours. The patches are in no case confluent, and, like the Derbyshire examples, there is a tendency for them to break along the line of contact with the lighter portion. When exposed to the weather for any length of time, and along the numerous cracks and fissures in the quarry, the rock weathers in the same peculiar manner as the examples above mentioned, that is, the dark patches resist the weathering to a greater degree than the lighter portion of the rock, and the patches stand out in relief similar to the encrinital limestone of some parts of Derbyshire.

In the Silverdale specimens, so far as I have made out, foraminifera are almost as numerous in the light portion of the rock as in the dark, which contrasts strongly with the specimens from Derbyshire, where the light part is said to be almost void of these remains. The same state of things exists in the Boulder-clay specimens. Other organic remains such as mollusca and corals are rare in the rock.

Now as to the physical conditions which led to the formation of this mottled limestone. Messrs. Barnes and Holroyd in the above cited paper give as their opinion that the dark patches have been removed from the original place of deposition, and intermingled and cemented into the lighter matrix. They further state that—"In the discussion upon a former paper read by us at the March meeting upon the pebbles found in the Windy Knoll conglomerate, Professor Boyd Dawkins threw out the suggestion that the pebbles might possibly be patches of a partially hardened calcareous mud from the sea-floor, and this idea would seem to offer an explanation of the presence of the dark patches in the light matrix, and it is not difficult to believe that their origin is due to one of the volcanic outbursts that are found represented in the limestone, for upon the same or a very near horizon, as far as we are able to make out, there exists a bed of volcanic rock. Given that these outbursts of volcanic activity were preceded by the usual earth shocks and sea disturbances, and the neighbouring presence of calcareous beds of dark foraminiferal mud, we have all the conditions necessary for the turning up from the sea bottom, and consequent removal to another area of the dark parts, together with the redeposition and consolidation, to produce the peculiar mottlings."

This highly interesting explanation of the mottling of the limestone appears to hold good with regard to the Derbyshire beds where there have been contemporaneous lava-flows (e.g. Toadstone) along with the deposition of the limestone; but how are we to account for the same phenomenon of mottled limestone so far away as Grange and Silverdale, where no contemporaneous igneous rocks are known to exist, unless it can be put down to the action of strong currents sufficient to remove the deposit from one part of the sea-floor to another, set up by the volcanic disturbances in the Derbyshire area, or can the area of these disturbances have been more widespread than is at present known? This is certainly a most interesting problem.

Unfortunately, I have been unable so far to investigate the beds immediately below the mottled ones at Silverdale to see if they agree with those in Derbyshire. Necessarily I am unable to give the actual thickness of the mottled beds. With reference to the contained foraminifera of these beds, I am hoping to make further investigations on them before publishing any note on the same. Some of the genera represented are *Nodosaria* sp. (*radicula*?), *Endothyra* spp. (abundant forms, *bowmani*?, *ammonoides*?), *Textularia* sp., *Trochammina* sp.

NOTICES OF MEMOIRS.

The President of the Royal Society on the Acquisition and Advancement of Knowledge.

THE following excerpts are from the Address delivered by Lord Rayleigh at the Anniversary Meeting of the Royal Society on November 30th, 1907 (published in Proc. Roy. Soc., Series B, vol. lxxx, pp. 77, 78, 1908).

How to keep pace with the Progress of Science.

"Enough has probably been said to illustrate my contention that much loss has ensued from ignorance and neglect of work already done. But is there any remedy? I think there ought to be. In all principal countries of the world we have now a body of men professionally connected with science in its various departments. No doubt the attention of many of these is so engrossed by teaching that it would be hard to expect much more from them, though we must remember that teaching itself takes on a new life when touched with the spirit of original enquiry. But in the older universities, at any rate, the advancement of science is one of the first duties of Professors. Actual additions to knowledge occupy here the first place. But there must be many who, from advancing years or for other reasons, find themselves unable to do much more work of this kind. It is these I would exhort that they may fulfil their function in another way. If each man would mark out for himself a field—it need not be more than a small one—and make it his business to be thoroughly conversant with all things new and old that fall within it, the danger of which I have spoken would be largely obviated. A short paper, a letter to a scientific newspaper, or even conversation with friends and pupils, would rescue from oblivion writings that had been temporarily overlooked, thereby advancing knowledge generally and sometimes saving from discouragement an unknown worker capable of further achievements. Another service such experts might render would be to furnish advice to younger men desirous of pursuing their special subject."

The Preparation of Scientific Papers.

"Another remedy for the confusion into which scientific literature is liable to fall may lie in the direction of restricting the amount of unessential detail that is sometimes prevalent in the publication of scientific results. In comparing the outputs of the present time, and of, say, thirty years ago, the most striking feature that appears is doubtless the increase of bulk in recent years, coming especially from

young workers stimulated by the healthy encouragement of direct research as a part of scientific education. But I think it may also be observed, and not alone in the case of such early dissertations, that there is, on the whole, less care taken for the concise presentation of results, and that the main principles are often submerged under a flood of experimental detail. When the author himself has not taken the trouble to digest his material or to prepare it properly for the press, the reader may be tempted to judge of the care taken in the work from the pains taken in its presentation. The tendency in some subjects to submit for immediate publication the undigested contents of note-books is one that we hear much of at the present time. It is a matter that is difficult for publishing bodies to deal with, except by simple refusal of imperfectly prepared material, with its danger of giving offence to authors of recognized standing, but it seems not unlikely that at present public scientific opinion would endorse such a course of action. A related difficulty and one that contributes to this trouble, is the tendency, noticeable in some public scientific organizations, to imagine that their activity is estimated by the number of pages of printed matter they can produce in the year. Probably no consideration is further removed than this from the minds of the educated public, whose judgment is alone worth considering."

REVIEWS.

I.—Geological Survey of England and Wales. Sheet 125: Derby. Price 1*s.* 6*d.*

Memoirs of the Geological Survey of England and Wales. Explanation of Sheet 125: The Geology of the Southern Part of the Derbyshire and Nottinghamshire Coalfield. pp. 199. Price 3*s.*

ON the scale of 1 inch to the mile only one geologically coloured map of this area is published which shows details of both solid and drift geology. We are told in the preface, "the distribution of the drift is not sufficiently great to obscure the general structure of the district."

The map is one of the new colour-printed series, and is full of detail and a great advance on the last edition in every way. Very elaborate legends are given in the margins, and we note a most useful novelty on the lower margin, i.e., an admirable coloured transverse section from west to east across the most important part of the map from a view of structure. Everyone concerned in the production of the map is to be most highly congratulated on its wealth of detail and general accuracy.

The memoir is written by Messrs. Gibson, Pocock, Weld, and Sherlock, with notes by Mr. Fox Strangways, and the striking note of the volume is the application of palæontological data throughout the parts dealing with the Carboniferous rocks.

The Carboniferous Limestone in the area consists of the portion of the North Staffordshire-Derbyshire anticlinal at Wirksworth and the Crich inlier, which are shown to belong to the *Lonsdalia* subzone of the *Dibunophyllum* zone. The limestones are succeeded by the

Limestone shales, here only between 400 and 500 feet thick. This term has been adopted for this map to replace the Yoredales of the previous edition, though the reasons given for adopting a different nomenclature for this sheet than was selected for the maps and explanatory remarks of Sheets 123 and 110 are somewhat ambiguous and not obvious. However, the important fact remains that the 'Limestone shales,' are recognised to be the equivalents of the Pendleside Series elsewhere. Albeit 'Limestone shales' is somewhat of a misnomer, because the shales have no faunal connection with the limestone deposit, and the amount of limestones found in the shales are only 2 or 3 per cent. of the total. It is, however, non-committal, and gives an opportunity for hedging later if found necessary, and it will be interesting to watch what line is taken in the sheet further north which will not be so far away from the type district.

The chapter on the Millstone Grits is important. These beds are thinning and dying out, and the stratigraphy presents difficulties of its own. It is interesting to note the presence of *Glyphioceras bilingue* above the Kinderscout Grit. This goniatite appears to characterise the upper part of the Pendleside Series and to persist in Lancashire as high as the Sabden shales. The chapters on the Coal-measures are from the pen of Mr. Walcot Gibson, and are excellent and full of detail. He has been careful to chronicle the occurrence of the fossils connected with each bed of coal, both plants and mollusca, and he finds that the distribution of the Lamellibranchiata reveals a general sequence similar, in the main, to that found to obtain in the North Staffordshire Coalfield. He attempts a certain amount of correlation between the Derbyshire and North Staffordshire Coalfields on palæontological data. As in North Staffordshire, certain marine bands have been discovered which will afford great help in fixing horizons, e.g. the Alton coal is considered to be the equivalent of the Crabtree of the Cheadle and Pottery Coalfields. Between the Coal-measures and the Permian series is a great unconformity, and this opens up a large question, as to what was the condition of things on the west side of the Pennine axis which prevented Permian rocks being laid down in Cheshire and Staffordshire.

The Triassic rocks are found not much to exceed 800 feet in thickness, and apparently all the members, which measure several thousand feet thick in Cheshire, are represented.

It is noted on p. 126 that the Bunter gravels contain pebbles with Silurian fossils similar to those found in Staffordshire.

Chapters on folds and faults, the superficial deposits, and economic geology are also included. It is curious that no Chalk flints have been definitely recognised in the drift; these erratics are very common further west at Barrow Hill, Rocester, and at Abbotts Bromley.

An appendix gives a detailed section of the shaft at Kilbourne Colliery, with the fossils found at each depth.

The authors are to be congratulated on the excellent volume they have produced. At last a memoir dealing with a colliery district has palæontological details put in a form which will be useful to the mining engineer who can appreciate them. WHEELTON HIND.

II.—Three Geological Survey Memoirs.

The Geology of the Country around Mevagissey. By Clement Reid, F.R.S.; with Petrological Contributions by J. J. H. Teall, D.Sc., F.R.S. pp. vi, 73, with 7 plates and 4 text-illustrations. Price 2*s*.—Colour-printed map, Sheet 353. 1*s*. 6*d*.

The Geology of the Country around Plymouth and Liskeard. By W. A. E. Ussher, F.G.S.; with Notes on the Petrology of the Igneous Rocks, by J. S. Flett, M.A., D.Sc. pp. vi, 156, with 4 plates and 15 text-illustrations. Price 3*s*.—Colour-printed map, Sheet 348. 1*s*. 6*d*.

The Geology of the Quantock Hills and of Taunton and Bridgwater. By W. A. E. Ussher, F.G.S. pp. iv, 109, with 15 text-illustrations. Price 2*s*.—Colour-printed map, Sheet 295. 1*s*. 6*d*.

IN the first of these memoirs we have a description of the small but complicated area extending from Tregoney to Veryan Bay and Mevagissey Bay. It is a region made classic by the early discoveries of 'Silurian' fossils by C. W. Peach, and has been more recently referred to in the pages of this Magazine (July and August, 1904, pp. 289, 403, and January, 1906, p. 33) by Mr. Upfield Green with the collaboration of Mr. C. D. Sherborn.

Although fossils had been found by Peach at Porthluney, we owe to Mr. Green the discovery of true Upper Silurian fossils in lenticles of limestone at that locality, probably of both Wenlock and Ludlow age. Interest naturally centres in the palæontological evidence, and we are glad to note the further important material gathered by Mrs. Clement Reid from the Ordovician quartzite of Perhaver Beach. By dint of much labour she obtained six species of trilobites, named by Mr. Philip Lake—

Cheirurus Sedgwicki, Salt.	*Phacops minus*, Salt.
Calymene Tristani, Brongn.	*Phacops incertus* (?), Desl.
Calymene Cambrensis, Salt.	*Asaphus Powisii*, Murch.

These species apparently represent beds of Llandeilo age, as noted by Salter, who first identified the *Calymene Tristani* from the Cornish strata.

The geological map of Mevagissey gives but little idea of the difficulties encountered in determining the structure in the cleaved, crushed, overthrust, and broken sedimentary and igneous rocks; and as Mr. Reid remarks, "there is enough unexplained in this small area to employ a skilled geologist for several years longer, and there is also plenty of work for the fossil collector and petrologist."

The author in describing the "Lower Palæozoic Rocks" takes us along the coast from the Dodman northwards to Gorran Haven and Mevagissey, and westwards to Carne and Veryan. The age of the Dodman Series is not known, but there is evidence of a sequence from the unfossiliferous Portscatho Series (of J. B. Hill) to the Veryan slates, limestone, and radiolarian chert, and the Gorran or Carne quartzite, which are of Ordovician age. Resting unconformably on the older strata are coarse conglomerates, grits, and slates grouped as of Lower Devonian age. Pictures of rock-structure are given, including pillow-lava and slickensided quartzite; also of honeycomb weathering,

which is stated by Mr. Reid to correspond with no internal structure of the rock, and is probably "due to some unrecognised organic agency."

In the chapter on Igneous rocks there is a description of the Gneiss of the Eddystone by Mr. H. H. Thomas, while notes on the Basalt, Dolerite, Felsitic Rocks, and Quartz-porphyry are contributed by Dr. Teall. There are short chapters on the superficial deposits and economics.

In his "Geology of the Country around Plymouth and Liskeard" Mr. Ussher points out that "the structure of the Devonian rocks of Cornwall, to which the area comprised in Sheet 348 furnishes the key, remained practically unknown until the year 1890." This topic was discussed by him during the excursion of the Geologists' Association to Plymouth at Easter, 1907.

In a region so complicated it is not surprising that it has taken many years to establish the main structure. Beyond marking in the Plymouth limestone and the various eruptive rocks, De la Beche made no attempt to depict the various types of stratified rock which he recognized in the Devonian area in the course of his comparatively rapid survey on the old one-inch maps; but, as remarked by Dr. Teall in the preface to this memoir, De la Beche's "facts were noted with such precision that the present author, from experience he had gained in the Devonian area of South Devon, was enabled so to interpret De la Beche's observations as to be able to give in 1890 a forecast of the probable structure in the Devonian rocks of Cornwall." Single-handed, Mr. Ussher has been occupied in the detailed mapping of the Devonian rocks from Torquay to Liskeard and St. Austell for a period extending over more than thirty years (though occupied elsewhere during portions of the time), but while gradually establishing the sequence and age of the main rock-divisions it was not until 1900 that he had satisfied himself with regard to the relative position of the Looe Beds and the Dartmouth Slates.

The present memoir embodies the detailed information on which the new geological map is based, and will be an invaluable guide to all who devote themselves to further research.

To the reader who has no personal knowledge of the district a summary of the leading characters and fossils of each division would have been a useful addition to the account of the general geology and structure given in the Introduction.

The Culm Measures appear nearly everywhere to be in faulted relation with the Devonian; but in some places Middle Culm Measures rest, apparently with marked unconformity, on Upper Devonian Slates.

There is a short chapter on evidences of New Red rocks, a brief reference to the possible Eocene deposit on the Hoe described by R. N. Worth, and descriptions of the various superficial accumulations and economics. The petrographical notes by Dr. Flett include accounts of the schalsteins, spilites, proterobases, diabases, and picrites, among the last-named being the well-known rock of Clicker Tor.

In the memoir on the Quantock Hills Mr. Ussher records observations for the most part made many years ago when the area was resurveyed on the old one-inch map, but these are supplemented by

notes made recently. The Devonian rocks from the Hangman Grits to the Pilton Beds are described, and the author remarks that "it is unsafe to regard the Morte Slates as anything older than the upper part of the Ilfracombe Group or the beds immediately overlying it."

Dr. Flett contributes a description of the Hestercombe syenite, which was discovered in 1811 by Leonard Horner, the rock being now described as a diorite.

The Carboniferous Limestone of Cannington is referred to the *Seminula* zone.

The author discusses the relations of the Carboniferous and Devonian, observing that while there is no evidence of unconformity between the Lower and Middle Culm Measures, yet "the existence of a considerable unconformity in South Devon and Cornwall leads one to think that the appearances of concordance are not to be trusted." The author is here rather more confident of the unconformity than he was in the Plymouth memoir (p. 103), wherein he did not deny the possibility that thrust-faults might explain the phenomena.

In the Quantock area, as in that of Plymouth, there is no proof of unconformity between Upper Devonian and Lower Culm Measures, but the junction "is often faulted and generally obscure."

The cherty beds of Coddon Hill have been regarded as homotaxial with those of Bishopston in Gower, and as equivalent to the so-called "Yoredale Beds," or to the Pendleside Beds of Dr. Wheelton Hind. Mr. Ussher is, however, inclined to regard the Devon-Carboniferous chert-beds as on a lower horizon than those of South Wales, and he adopts the view put forth by Dr. G. J. Hinde and Mr. Howard Fox that the Devon beds represent the deeper-water conditions of the Carboniferous Limestone. The proof of deeper-water conditions is, however, a moot point.

Dealing generally with the effects of great earth-movements, Mr. Ussher argues that "if the Devon Lower Culm-measures correspond to the Carboniferous rocks above the Carboniferous Limestone, and the Upper Devonian in no part represents the latter, the south shore of a strait in the Carboniferous Limestone sea would have been not far south of Cannington Park; and south of this the Carboniferous Limestone would not be found." He, however, adds, "The equivalence of the Lower Culm Chert Beds to Carboniferous Limestone, owing to a more or less uniform deepening of the sea-bed to the south and south-west of Cannington Park, is here advocated."

Full particulars are given of the New Red rocks, including (1) the Lower Sandstones and Marls, grouped as Permian, and (2) the Pebble Beds and Conglomerate, the Upper Sandstones and Upper (Keuper) Marls, grouped with the Trias. Mr. H. H. Thomas contributes petrographical notes on the New Red sands and sandstones. Short descriptions are given of the Rhætic beds and Lower Lias which are exposed along a small portion of the coast which comes in the area of the map, near St. Audrie's, east of Watchet. The work concludes with some account of the Pleistocene and Recent deposits, and of water supply and economic products, including the famous Bath bricks of Bridgwater.

III.—Geological Survey, Western Australia. Bulletin No. 29. Parts I and II: A Report upon the Geology, together with a Description of the Productive Mines of the Cue and Day Dawn Districts, Murchison Goldfield. By Harry P. Woodward, Assistant Government Geologist. 8vo. With maps and sections. Perth, W.A., 1907.

MR. HARRY P. WOODWARD, a well-known pioneer of West Australian geology, has supplied in this report much valuable information respecting the mining districts which it embraces, forming part of the great "Murchison Goldfields."

Part I (Cue and Cuddingwarra Centres) opens with an account (section 1) of the Cue mining district. The township of Cue is the official centre of the Murchison goldfields, and is connected by railway with Perth; it is 1,485 feet above the sea-level, and lies upon the western edge of a broken granite plateau, which extends for a considerable distance to the eastward. Starting in 1891 as a mere digger's camp, it became changed in 1893 into a mining centre; reefs were opened up, of which several passed into the hands of companies with ample machinery to develop them. Nevertheless, it was soon discovered that the production did not justify these preparations, and failure resulted. In spite of adverse conditions, however, the district has yielded since the earliest records appeared from 15,000 to 20,000 ozs. of fine gold per annum.

Geology.—Gold deposits occur in the crystalline series in more or less lenticular-shaped amphibolite belts, surrounded by gneissic granite, the whole being intersected by numerous felspathic dykes. In the district under review the amphibolites are more coarsely crystalline in structure than is usual in the auriferous belts, while the quartz reefs in them are of rare occurrence. In the acidic series, however, instead of gneissic granites there appears to be a magmatic intrusion of granodiorite, a rock intermediate between the hornblende granites and the quartz diorites, and containing numerous productive lodes.

A characteristic feature of the Cue district is the occurrence of table-topped hills rising abruptly about 60 feet above the general level of the country. These hills are the denuded remnants of a once extensive plateau.

Mining.—Section II contains a detailed description of the mines of Cue, with tables showing their yield from about 1896 to 1906, according to the length of time they have been worked.

Numerous illustrations from photographs showing the physical features of the country and coloured geological maps accompany the report.

Part II deals with a portion of the area included in the Day Dawn mining district, which adjoins the Cue district to the southward.[1] Owing to excellent management mining in this area is carried on very profitably, the most productive of the mines having yielded, up to the end of 1906, 778,606 oz. of gold, out of 841,023 tons of ore crushed. Over 95 per cent. of this yield comes from one mine.

[1] See also Geol. Mag., Dec. V, Vol. III (1906), p. 277.

Geology.—The geology of the Day Dawn district differs materially from that of Cue, the granodiorite of the latter being entirely absent. The whole area is therefore classed as greenstone, with its schistose and altered forms due to hydration and the attendant forces, such as compression, elongation, crushing, and shearing. The term greenstone is meant to include not only the normal hornblende schists, amphibolites, etc., but also the diorites, diabases, and andesites which occur in this district, though they are generally so highly altered at the surface as to render the delineation of their boundaries a very difficult task.

The amphibolites are highly foliated and hydrated near the surface. A magmatic igneous intrusion occurs, composed probably of diabase, the augite of which has been changed into hornblende and epidote. The lodes of the district occur in the "igneous zone," in the "contact zone," and in the "amphibolite zone," the principal productive mines being contained in the contact zone, in which, though there are only eight gold-bearing reefs, the production is 97 per cent. of the total yield.

Section II is devoted to a full description of the productive mines of the district, and it concludes with two appendices containing (1) a list of the Cue rocks, (2) notes on some typical Cue rocks, by E. S. Simpson, F.C.S.

This report is also well illustrated.

We must congratulate Mr. Woodward upon the ability with which he has conducted the survey of this important mining area. He has shown no less a grasp of the economic problems presented to him in the course of his work than of the geological ones.

A. H. F.

IV.—Report relating to the Geology of the East Africa Protectorate. By H. Brantwood Maff, B.A. Colonial Reports—Miscellaneous. No. 45. East Africa Protectorate. London: H.M. Stationary Office, 1908. With map and 2 text-illustrations. Price 6*d*.

WE welcome the publication of this important and interesting report, which has been issued at a price that may be regarded as exemplary.

Mr. Maffl was engaged between December, 1905, and September, 1906, in investigating the geology of the East Africa Protectorate, mainly with the object of reporting on the prospects of obtaining better supplies of water for drinking and other purposes. The region consists of a long but comparatively narrow belt of country, extending from the Island of Mombasa on the coast of the Indian Ocean to Port Florence on Victoria Nyanza, a distance of 580 miles as measured along the course of the Uganda railway.

This region comprises (1) the *coastal belt* formed of raised coral rock and sands, followed inland by a mass of shales and underlying sandstones, with occasional limestones, that dip towards the coast, and are in great part of Jurassic and in part probably of Triassic age. This coastal belt extends for 57 miles, and rises to over 1,000 feet above sea-level.

The greater portion of the region consists of (2) a broad intermediate tract of gneiss, and (3) a vast area of volcanic rocks which extend to the shores of the Victoria Nyanza.

The author points out that the valleys throughout the coastal belt were eroded when the land stood at least 60 feet above the present sea-level, and after the formation of the coral reef. There have, therefore, been considerable changes in level in comparatively recent geological times.

It is reckoned that an artesian supply of water might be met with in the sandstones below the Jurassic shales at a depth of about 1,600 feet near Mombasa. Other local sources of water, and possible further sources in different parts of the Protectorate, are duly discussed.

Attention has been paid to the soils on the several rock formations. On the gneiss there is much red earth with limestone nodules (Kunkar), the origin of which is explained by the author. He also points out the injury that is done when the forest growth is removed from the natural slopes, as the rains then readily carry off the red earth.

In the volcanic region there are numerous 'fumaroles,' which constantly emit clouds of steam, and there are some warm springs. The superficial deposits include red clay, like the Indian 'laterite,' black cotton soil like the 'regur,' and loam or loess. In places there are thin layers of pisolitic iron-ore, known by its Indian name 'muram,' and this, as the author remarks, is smelted by the natives, who manufacture spears and knives from the iron.

In conclusion, it may be mentioned that throughout the report many other matters of general geological interest are ably treated by the author.

V.—Superficial and Agricultural Geology, Ireland.

UNDER the above general title Mr. G. H. Kinahan, M.R.I.A., etc., has commenced a series of shilling handbooks, "Kinahan's Booklets," published by Messrs. Sealy, Bryers, & Walker, of Dublin. Two are already issued: No. 1, Lime, and No. 2, Soils. In the first work he deals with the utility of lime as a manure, and points out its natural sources in Ireland. That lime is required by many fruit-trees is shown by analyses, although its prime importance in the cultivation of the land is the influence it exerts on the constituents of the soil. Thus peaty lands when well drained can be successfully cultivated with the aid of lime manures. In the second work Mr. Kinahan deals with "Soils, Natural and Augmented," or, in other words, as modified by tillage and manures. The soils on different formations, on upland and lowland, are described, and much attention is given to the drainage and cultivation of the bog lands. The importance of due consideration of the subsoil is rightly urged, and indeed a soil-map which did not indicate the subsoils would have little or no practical value.

As early as 1837 Portlock, who was in charge of the Geological branch of the Ordnance Survey in Ireland, established at Belfast a laboratory for the examination of soils, and he recognized the importance of ascertaining not only the soluble and insoluble

ingredients, but also the physical characters of the soils. No one since his time has paid so much attention to questions of economic geology in Ireland as Mr. Kinahan, and he now records, sometimes in very forcible language, his views on agricultural matters gathered during an experience of sixty years of the soils and subsoils of the country.

VI.—Soil Surveys in the United States.

THE Bureau of Soils of the U.S. Department of Agriculture issued its seventh report on Field Operations during 1905 (Washington, 1907). The Bureau comprised Mr. Milton Whitney, the Chief, a scientific staff of men, with forty-five Assistants in Soil Survey, a chief clerk, and editor. During the year 1905, 21,289 square miles, or 13,624,960 acres, were mapped, the average cost of the field-work being reckoned at rather less than 9*s*. per square mile. Up to the end of the year soil survey work had been undertaken in all but three of the States, in four territories, and also in Porto Rico.

The general results of the work demonstrate the very varied soil and climatic resources of the agricultural domain of the country; and bring to notice additional soil-types adapted to the production of many kinds of crops. Interesting examples are given of special adaptation of soils to crops, such as tobacco, sugar-beet, sugar-cane, grape, peach, cotton, as well as corn; and tests have been made to determine the manurial requirements of the more important types of soil. It is thus coming to be generally recognized that the soil surveys are very helpful to the farmers of any State, in indicating the adaptation of soil to particular crops, and the means to be taken for their maintenance and increase.

That the soil-maps of the United States, like those of some European areas, represent the subsoils rather than the actual and constantly varying soils, is evident. Taking, for example, one of the published soil-maps, that of the Everett area, in the north-west part of Washington on the eastern shore of Puget Sound, we find it to represent the characters (1) of mountainous uplands which rise to 1,800 feet, (2) of lower hills and bench-lands, which vary from 25 to 600 feet in elevation, and (3) of the valley region, with alluvial bottom-lands and delta-flats, mostly not exceeding 20 feet in elevation.

The mountain region (1) is stated to consist largely of schists with a backbone of diorite and granite, and to be separated from the lower hills and benches in the area by an abrupt escarpment. The soils are due partly to the effects of glaciation, partly to the residual weathering of the schists and igneous rocks, which are exposed in numerous places, sometimes extensively. On the map, however, this mountain area is coloured uniformly of one tint, according to the characteristic soil, termed the *Miami stony loam*.

The remainder of the area has a foundation of Tertiary shales, sandstones, and conglomerates, which have been thrown into folds, and outcrop occasionally along some of the streams. Elsewhere these strata are buried beneath accumulations of till, and stratified deposits of clay, sand, and gravel.

The outcrops of the Tertiary strata are not indicated on the map, but the entire area is coloured according to the distribution of what would ordinarily be termed the main subsoils. Thus there are areas of many square miles coloured simply as *Miami sandy loam*. The surface soil is stated to comprise up to 15 inches "of brown sandy loam of medium texture, containing a good proportion of fine gravel. The subsoil, to a depth of 36 inches or more, consists of a yellow or gray light sandy loam or sand, containing fine gravel. From 5 to 10 per cent. of larger gravel and glacial cobbles is scattered through both soil and subsoil, and occasional glacial erratics of larger size are found. Irregular bands of gravel are found here and there at different depths throughout the type."

Again, the *Galveston coarse sand* "consists of 3 feet or more of medium to coarse loose gray sand, containing gravel of various sizes." The *Muck* "consists of vegetable mold in a more or less decomposed condition, mixed with silt or other earth, and extending to a depth of from 1 to 3 or more feet."

The value of soil surveys so far as the maps are concerned is in the indication they give of the main characters of the subsoil or weathered geological formation beneath the soil. Added to this information, that relating to the actual depths of soil and subsoil, obtained by means of hand-borers or spade, and the mechanical and chemical analyses of the materials, combine to give data of great practical value.

VII.—Petrology for Students: An Introduction to the Study of Rocks under the Microscope. By Alfred Harker, M.A., F.R.S. Fourth edition. pp. viii, 336, with 91 text-illustrations. Cambridge: at the University Press, 1908.

A NEW edition of this eminently concise and useful handbook will be welcomed not only by students of petrology, but by geologists in general, enabling them, as it does, to keep in touch with the progress of the science and the nomenclature of the rocks.

It is remarkable that the author has revised and brought his book up to date not only without increasing its size, but by a reduction of ten pages compared with the last edition.

Since then Mr. Harker has published the results of his researches on the Tertiary Igneous Rocks of Skye (Mem. Geol. Survey, 1904) and of other investigations among the Inner Hebrides. Thus we find brief reference to his "Mugeary type" of olivine-dolerite, recorded as mugearite in the index, though the author has purposely refrained from using the rock-name in the text. Other varieties of rock are similarly treated, such as the olivine monzonite (Kentallen type) and a connecting link between syenites proper and nepheline-syenites (Pulaski type), which are recorded only in the index as kentallenite (Hill and Kynaston) and pulaskite (J. F. Williams). The value of the index is enhanced by the insertion of the names of the authors responsible for the rock-terms.

The descriptions of the sedimentary rocks and of the effects produced by metamorphism are amplified by references to the more important publications on these subjects.

VIII.—Geology of the Philippine Islands.

The Geology of the Compostela-Danao Coalfield. By Warren D. Smith. Philippine Journal of Science, vol. ii, No. 6, sect. A, Dec. 1907, pp. 377–405, pls. i–xiv, maps and sections.

THIS is a comprehensive paper dealing with climate, vegetation, population, hydrology, topography, physiography, and geology, both stratigraphical and economic. It concludes with a classification of Cebu coal by A. J. Cox. One of the chief points of interest in the paper is the account of the 'upper limestone,' which contains fossils identical with those figured by Martin in his monograph on the Tertiary of Java. A volume on the palæontology is promised later on. Besides a series of moluscan genera quoted Mr. Smith points out that the foraminiferal genus *Lepidocyclina* (*Orbitoides*) predominates, while another characteristic fossil is found in the alga, *Lithothamnium ramosissimum*, Reuss. Plates are given of this last form. Following Martin in his work on Java, and Newton & Holland in their paper on Formosa, the author says, "I have been inclined to assign this formation, at least this horizon of it, to the Miocene, although fossils from a very similar limestone which I have also examined in the field in Batan Island, have been classified by a European palæontologist as Oligocene." And he thinks that future research may reveal this horizon in Cebu.

IX.—The Life and Work of George William Stow, South African Geologist and Ethnologist. By Robert B. Young, M.A., B.Sc., Professor of Geology and Mineralogy at the Transvaal University College, Johannesburg. 8vo; pp. vi, 125, with portrait. London: Longmans, Green, & Co., 1908. 3*s*. 6*d*.

IT is well that a record of the remarkable career of G. W. Stow has been written. He was one of the pioneers in South African Geology, associated with Rubidge and Athertone, who followed "the Father of South African Geology," Andrew Geddes Bain. Stow was born at Nuneaton in Warwickshire on February 2nd, 1822. Devoted in youth to engineering subjects, he was nevertheless articled by his father to a medical man in London, "but failed to acquire any love for his profession." History, natural science, and poetry were his favourite studies. In 1843 he emigrated to South Africa and there for nearly forty years he laboured to live, and lived to prosecute researches on the geology and ethnology of his adopted country. As remarked by J. W. Hulke, in an obituary notice, "Mr. Stow's work was carried on under circumstances of such continued pecuniary difficulty and personal hardship as nothing but the sacred fire of a pure love of investigation for its own sake, rather than for any monetary emoluments which might ultimately accrue from it, would have enabled him to endure." He began life in South Africa as a Church teacher and catechist, but soon had to take up arms in one of the Kaffir wars. Farming for a while engaged his attention, then he successively became bookkeeper in a merchant's office, broker and

[1] O. H. Reinhold, Engineering Journ., 1908, xxxv, 510.

commission agent, manager of a general business, wine merchant, diamond dealer, and auctioneer. Meanwhile he had seized all opportunities for geological studies; he had obtained remains of a Labyrinthodont named *Micropholis Stowi* by Huxley, and had been engaged in an expedition in Griqualand, which led to his most important publication, "Geological Notes upon Griqualand West," read before the Geological Society of London in 1873. Ultimately Stow was officially engaged in geological surveys of the country between the Vaal and Modder Rivers in the Orange Free State, and became the discoverer of the Vereeniging coalfield. He died on March 17th, 1882. The story of his life is full of interest and pathos, and we commend it to our readers.

REPORTS AND PROCEEDINGS.

I.—Geological Society of London.

1.—*March 4th*, 1908.—Professor W. J. Sollas, Sc.D., LL.D., F.R.S., President, in the Chair.

The following communications were read:—

1. "On *Metriorhynchus brachyrhynchus*, Deslong., from the Oxford Clay near Peterborough." By E. Thurlow Leeds, B.A. (Communicated by Dr. Henry Woodward, F.R.S., F.G.S.)

This species was first described by E. E. Deslongchamps in 1868, and was based on an imperfect skull, obtained from the department of Calvados, Lower Normandy. He was led to distinguish it from other species by the shortness of its snout. He mentions one other mutilated skull found near Poitiers, and there is a third in the Muséum de la Faculté des Sciences at Caen. Two skulls have recently been obtained by Mr. A. N. Leeds, F.G.S., from the Saurian zone of the Lower Oxford Clay, in the neighbourhood of Dogsthorpe, Peterborough. No other parts of the skeleton were found with them, even the mandibles being missing. The two specimens belong to the same species, and after comparison with descriptions, figures, and photographs of the specimens above mentioned, they have been referred to *Metriorhynchus brachyrhynchus*. This is believed to be the first recorded occurrence of the species in England; and the specimens help to throw additional light on the cranial osteology of the species, especially in the parts which are wanting in the type-specimen. They are therefore described in order to amplify Deslongchamps's description. The skulls are neither of them perfect, but one fortunately supplements the other, and both are perfect in one of the most interesting parts—the frontal region and the part from the nasals to the premaxillæ. The specimens are compared and contrasted throughout with *M. superciliosus*. It is found that these specimens possess the main characteristics determining Deslongchamps's species, although the prefrontals, which are in keeping with the general massive development of the skull, are wider than he supposed; and it is possible to reconstruct with almost absolute certainty the region of

the posterior nares, showing the bifurcated opening with the vomerine element running back almost to the sphenoid, a feature which the author thinks will prove to be common to all species of *Metoriorhynchus*.

2. "The High-level Platforms of Bodmin Moor, and their Relation to the Deposits of Stream Tin and Wolfram." By George Barrow, F.G.S. (Communicated by permission of the Director of H.M. Geological Survey.)

In this area there are three platforms—one, which is marine and of Pliocene age, terminating in a steep slope of 430 feet above the sea; a second, at a height of 750 feet, seen about Camelford and at the foot of Delabole Hill; and a third, a little under 1,000 feet, first recognized on Davidstow Moor. The valleys cutting the lowest platform are found to have been much deepened since the uplift of the platform to its present level; but the features thus caused gradually die out in the higher part of the valleys, disappearing in the River Camel about 22 miles from the sea. At the higher parts of all these platforms, marshes are frequently found.

The superficial deposits which bear tin above the 750 foot platform differ markedly at times from those below it, as here ancient wash is preserved—possibly protected, by a snowfield or by being frozen, from the denudation which has destroyed them below this level. These deposits are not so concentrated as the stream-sorted material below, but they have been frequently worked in past times until the industry languished, in consequence of the difficulty or impossibility of separating the wolfram contained in the enriched portion of these deposits from the tin-ore. This difficulty having been overcome, and the wolfram being even more valuable than the tin-ore, the industry is now reviving. The veins from which the wolfram is derived have been found close to the points where the 'wash' is enriched by their denudation. The method of working is described, and it is shown that the success of it depends to some extent on the slope of the granite floor on which the detritus rests; otherwise the deposit becomes waterlogged, and the method of separation adopted is expensive to carry out.

On Bodmin Moor the larger marshes have a floor of kaolinized granite; but there is a difficulty in working it at many points, in consequence of the waterlogging by peaty water. This difficulty does not exist at Stannon Marsh, which has sloping sides instead of a flat base, the cycle of denudation in this case being incomplete.

2.—*March 18th*, 1908.—Professor W. J. Sollas, Sc.D., LL.D., F.R.S., President, in the Chair.

The following communications were read:—

1. "The Carboniferous Rocks at Loughshinny, County Dublin, with an Account of the Faunal Succession and Correlation." By Charles Alfred Matley, D.Sc., F.G.S., and Arthur Vaughan, B.A., D.Sc., F.G.S.

After an introduction recalling the succession at Rush, already described by the authors, a detailed account is furnished of the various

sections in the Loughshinny area. About 1,100 feet of Carboniferous rocks are exposed. They consist mainly of limestone, but also include a thick mass of conglomerate and many intercalated beds of shale and chert. The rocks have been much folded, and to some extent faulted. The lowest rocks belong to some part of the *Dibunophyllum* Zone, the higher range through *Cyathaxonia* Beds into *Posidoniomya* Limestones and shales of Pendleside age. The Lane Conglomerate may be on or near the horizon of the Rush Conglomerate. Local decalcification has caused the more or less complete disappearance of some of the *Cyathaxonia* and *Posidoniomya* Limestones. The following table gives the position and correlation of various members of the sequence:—

Stratigraphical Zones.	*Thickness in feet.*	*Palæontological Zones.*	*Correlation with the Rush area.*
Loughshinny Black Shales.	110.	Upper Zone. *Posidoniomya* (P_2)	Not represented.
Posidoniomya Limestone Group.	260	Lower Zone. *Posidoniomya* (P_1)	Do.
Cyathaxonia Beds (base not seen).	200	*Cyathaxonia* subzone (locally divisible into D 3*b* D 3*a* but overlapping).	*Cyathaxonia* Beds of Bathing Place and Grant Hill.
(Gap)	(Gap)		
Dibunophyllum Limestone	100.	Upper Zone. *Dibunophyllum* (D2)	Curkeen Hill Limestone.
(Gap)	(Gap)		
Holmpatrick Limestone.	180		Carlyan Limestone.
Lane Conglomerate.	200	D (of unknown position).	Rush Conglomerate Group.
Lane Limestones.	60		Rush Slates (top part only).

The region was close to an old shore-line of the Carboniferous Limestone Sea, the actual position of which appears to have been almost parallel to, and a short distance seaward of, the present coast-line between Rush and Skerries.

The paper closes with faunal lists from the various subdivisions and exposures, and an account of the faunal succession and correlation, both by the second author.

2. "A Note on the Petrology and Physiography of Western Liberia (West Coast of Africa)." By John Parkinson, M.A., F.G.S.

The country is low-lying, with a gradual rise northward from shore-level, and rivers mature in character with alluvial flats raised above flood-level. Where the River Tuma falls into the River St. Paul the

remnant of a hanging valley can be seen. Flat-topped ridges and isolated hills trending parallel to the foliation of the gneiss are characteristic of the country around Sanoyei and Boporo. There is a striking absence of late deposits of old gravels and sands.

In the southern part of the district there are indications of a series of garnetiferous gneisses, tremolite schists, kyanite schists or gneisses, garnet graphite gneisses, etc., associated with others of granitic type, the latter being apparently free from microcline and containing a pleochroic pyroxene. These rocks are replaced in the north by biotite gneisses and hornblende schists, which have an approximate and singularly constant east and west (magnetic) strike in their foliation. Microcline is common. These old crystalline rocks are cut by an extensive series of basalts and ophitic dolerites, resembling so closely the post-Cretaceous dykes of Southern Nigeria that it is difficult to avoid the conclusion that they are of the same age.

3.—*April 1st*, 1908.—Professor W. J. Sollas, Sc.D., LL.D., F.R.S., President, in the Chair.

A Special General Meeting was held at 7.45 p.m., before the Ordinary Meeting, for the purpose of considering and voting upon the following motion proposed by Mr. E. A. Martin, and duly seconded:—

> "That the Council be requested to take the necessary steps, at an early date, in order to allow of the admission of women to full Fellowship of the Geological Society of London."

After discussion, the following amendment proposed by Dr. A. Smith Woodward, and seconded by Mr. H. A. Allen, was voted upon, and passed by 43 to 34:—

> "That it is desirable that women should be admitted as Fellows of the Society, assuming that this can be done under the present Charter."

The foregoing amendment having then been declared a substantive motion, the following amendment to it was proposed by Mr. H. B. Woodward, and seconded by Mr. O. T. Jones:—

> "That a poll of all the Fellows of the Society resident in the United Kingdom be taken, to ascertain whether a majority is in favour of admitting women to the Society, and, if so, whether as Fellows or as Associates."

This was agreed to by 54 to 24, and was declared a substantive motion by show of hands.

An Associate is defined in the proposed New Section of the Bye-laws, submitted to the Special General Meeting held on May 15th, 1907, see Quart. Journ. Geol. Soc., vol. lxiii, Proc. p. lxxiii.

ORDINARY MEETING.

The President announced that the Council had adopted the following resolution:—

> "The Council of the Geological Society has heard with much regret of the death of Dr. Henry Clifton Sorby, who served on the Council for many years, and occupied the Presidential Chair during the Sessions 1878–80. The Council desires to place on record its high appreciation of the invaluable services rendered by Dr. Sorby to the Society and to the Science of Geology."

4.—*April 15th*, 1908.—Dr. J. J. Harris Teall, M.A., F.R.S., Vice-President, in the Chair.

The following communications were read:—

1. "The Geological Structure of the St. David's Area (Pembrokeshire)." By J. Frederick N. Green, B.A., F.G.S.

With a view to the elucidation of controverted points in the geology of the St. David's area, the author has mapped the district in considerable detail on the 6 inch scale. The Cambrian Rocks, the succession of which is well known, were first traced and were found to be greatly faulted. The faults have been followed into the underlying volcanic tuffs (Pebidian), and the succession within the intervening blocks of country determined and pieced together. In this way the Pebidian has been subdivided into fourteen horizons, with a total visible thickness of over 3,000 feet. The tuffs are described in some detail, and the subdivisions classified into four series—the lower two of which are composed chiefly of trachytic pebbles in a chloritic matrix, and are usually separated by a peculiar schistose quartz-felspar-porphyry sill. The third series is composed of fragments of rhyolite and hälleflinta in a silicified matrix, and the topmost now principally consists of highly sheared schistose beds. The volcanic fragments throughout the Pebidian are rolled, and have often undergone changes before deposition: thus the tuffs appear to be mainly, if not wholly, detrital.

By the aid of this succession, an unconformity between the Pebidian and the Cambrian is demonstrated, the position of the basal Cambrian conglomerate on the volcanic series varying by at least 1,000 feet. The red coloration of the beds immediately underlying the conglomerate is due to staining.

The schistose sill has been traced into the porphyritic margin of the St. David's granophyre (Dimetian), to which it is allied petrographically; and it is inferred that the granophyre is a laccolitic intrusion in the Pebidian. The boundaries between the granophyre and the Cambrian are prolongations of faults proved in the latter; except at one point in the well-known Porthelais district, which, on account of its importance, has been mapped on the scale of 25 inches to the mile. A trench specially opened at this point exposed basal Cambrian rocks resting upon a denuded surface of the granophyre, which is therefore of pre-Cambrian but of post-Pebidian age.

The relationships of the basic igneous rocks west of St. David's, which have hitherto been held to be Pebidian lavas, are discussed, and the conclusion is reached that they are all post-Cambrian intrusions. Finally, it is suggested that the word Pebidian should be revived as a general term.

2. "Notes on the Geology of Burma." By Leonard V. Dalton, B.Sc., F.R.G.S. (Communicated by Dr. A. Smith Woodward, F.R.S., F.L.S., V.P.G.S.)

The object of this paper is to present the results of geological expeditions in the Irawadi Valley, carried out by the author and Mr. W. H. Dalton between 1904 and 1906, and to correlate these observations with those made by previous writers, thus summarizing present knowledge of the geology of Burma in general, and of the

Tertiary System in particular. The classification of rocks arrived at is shown in the following table:—

			Feet.	
Irawadi Series			20,000	Pliocene.
Arakan Series	Pegu Group		7,500	Miocene.
	Bassein Group		8,000	Eocene.
Axial Series	Upper	*Cardita* Beds	.....	Cretaceous.
		Halobia Limestone	.....	Triassic.
		Shales and grits	.....	(?)
	Lower.	Flaggy shales and sandstones	.....	(?)

The oldest rocks, not comprised in the above synopsis, include representatives of the Silurian, Devonian, and Carboniferous Systems, but little of their detailed geology is known. The *Cardita* Beds may be correlated with the Cretaceous of India. The 'Chin Shales' of Dr. Noetling seem to form part of the Bassein Group, of Eocene age, which is of much greater thickness than hitherto supposed, and the group rests presumably more or less conformably on the beds below. The fauna is chiefly shallow marine in facies. These rocks flank the Arakan Group on both sides, and in the south form the backbone of the range, where they have been considerably metamorphosed. The Pegu Group probably overlaps the preceding, and is regarded as of Miocene age, although the fauna has many relationships with that of the French Eocene. *Lucina globulosa* is described as the first European Miocene species recorded from Burma. Estuarine conditions came on towards the close of Miocene time, and, in the estuary of the Pliocene precursor of the Irawadi, anticlinal islands of partly consolidated Miocene materials were formed. Around and eventually over these islands a great thickness of fluviatile deposits was laid down, corresponding to the Siwalik Beds of the Indian Peninsula. Finally, post-Pliocene denudation and upheaval revealed the Miocene islands as inliers, while the Irawadi has left its gravels in patches throughout the region. A list of fossils is given, and the species new to Burma, some of them new to science, are described.

II.—Mineralogical Society.

March 17th, 1908.—Prof. H. A. Miers, F.R.S., President, in the Chair.

(1) On the occurrence of metamorphic minerals in calcareous rocks in the Bodmin and Camelford areas; by G. Barrow and H. H. Thomas. The pneumatolytic action is not contemporaneous with the thermo-metamorphism produced by granite intrusions; the gaseous intrusions are later, and often produce their greatest effect beyond the zone of 'contact-action.' The species of mineral produced depends on the nature of the rock penetrated by the gases. In killas, tourmaline is commonly produced; but in calcareous rocks, axinite and a variety of other minerals result from the pneumatolysis. In the Bodmin area the minerals formed by pneumatolytic action in the calc-flintas are axinite, hedenbergite, epidote, yellow garnet, actinolite, and another amphibole occurring in minute dark-brown needles. In the Camelford area the minerals are mainly due to contact metamorphism. The most conspicuous are yellow garnet, epidote, and idocrase, a mineral which

has not hitherto been recorded from Cornwall.—(2) A protractor for use in constructing stereographic and gnomonic projections; by A. Hutchinson. A short historical account was given of the stereographic projection, and a protractor designed to facilitate its construction was shown. By the aid of this protractor the radii of both great circles and small circles could be readily determined. It can also be applied to the construction of the gnomonic projection and to measuring the angles between planes and zones.—(3) Supplementary notes on the mineral kaolinite; by A. B. Dick. Further observations on the optical characters of kaolinite from Anglesea lead to some alterations in the data given in a previous paper. The refractive index is about 1·563 for sodium light, and the optic axial angle, 2 V, is about 68° instead of 90°. The double refraction is very low. Kaolinite from limestone at Hambleton quarry, Bolton Abbey, Yorkshire, and from sandstone near Newcastle-on-Tyne were described.—(4) An attachment to the goniometer for the measurement of complex lamellated crystals; by H. L. Bowman. The apparatus, consisting of a small screen pierced by a pin-hole, can be attached to a goniometer, and is capable of adjustment so that minute portions of a crystal face can be successively illuminated.—(5) A new form of quartz-wedge, a modification of the Wright-wedge; by J. W. Evans. A quartz-wedge cut parallel to c is placed over a gypsum-plate parallel to a showing red of the first order, and extending beyond the thin end of the wedge, so that the projecting portions can be used as an ordinary gypsum-plate. The region where the wedge overlies the gypsum is graduated at the position of exact compensation and at each thousand micromillimetres of relative retardation. If when placed over a mineral in the diagonal position the black band is moved towards the thin end of the wedge, the direction of insertion is that of the vibrations which traverse the mineral with the smaller velocity; if towards the thick end, the direction is that corresponding to the greater velocity.—(6) Calculation of the chance that the double refraction of a crystal section cut at random shall exceed a particular fraction of the maximum; by H. Hilton. The problem is soluble completely for a uniaxial and partially for a biaxial crystal.

CORRESPONDENCE.

ON THE DATE OF PUBLICATION OF FREDERICK DIXON'S "GEOLOGY OF SUSSEX."

Sir,—It will be remembered that Frederick Dixon died in 1849, leaving his "Geology of Sussex" in manuscript, and that Richard Owen undertook to see it through the press. John Morris, in his "Catalogue of British Fossils," 2nd. ed., 1854, notes that Dixon's book was published in 1852 (not 1850 as stated on the title-page), and this supported by rumour led William Davies to make the same statement in some of his letters (MSS. concerning types of "British Fossil Vertebrata," Geol. Dept. Library, Brit. Mus. (N.H.), Pressmark 16.0. W., p. 29), in which statement he was not alone. A certain amount of uneasiness has thus arisen regarding this book and the

numerous specific names it contains, and the following notes would seem to settle the matter in a fairly satisfactory manner:—

On October 13th, 1849, Edward Forbes wrote to Owen saying he had just heard of the death of Dixon and that his part of the MS. could be finished in two or three days. On February 2nd, 1850, G. B. Holmes wrote to Owen, asking how Dixon's work is getting on. On December 30th, 1850, George Landseer, the artist, wrote to Owen saying "what a nice book Mr. Dixon's makes, a very useful one . . . I was looking over it the other day, and it seems carried out with great care." W. H. Fitton, on February 4th, 1852, wrote to Owen as follows: "During some weeks of the last summer made an acquaintance with the widow of your late friend Mr. Dixon. I obtained from her a copy of her husband's book on the fossils of the chalk, etc., at the usual bookseller's price of £3 3*s.* 0*d.*" Fitton further notes that her agreement with Longman expired in December, 1851, and with his usual kindness suggests that Mrs. Dixon should not be allowed to be at any loss over its production. Further, Messrs. Longman, Green, & Co. have favoured me with a letter dated 10th March, 1908, in which they say that Dixon's Sussex "was published in December, 1850."

I think we may therefore, on this evidence, safely accept the date 1850, as stated on the title-page.

C. DAVIES SHERBORN.

THE NOMENCLATORAL HISTORY OF THE CORAL *CANINIA*.

SIR,—In the April number of the GEOLOGICAL MAGAZINE, pp. 158–171, Mr. R. G. Carruthers, in addition to his admirable description of *Caninia* and of its contained species, enters fully into the question of its nomenclature. Since this question has given rise to some controversy, and is by no means easy of settlement, a consensus of opinion on the subject is desirable. If I venture to intrude on a field outside my own special work, it is only as a student of nomenclature and bibliography, and in response to a definite request for my opinion made last November by Dr. Arthur Vaughan.

After looking up the literature with the help of my colleague, Mr. W. D. Lang, I sent Dr. Vaughan a long letter, which came to the same conclusions regarding the interpretation of *Caninia* and of its genotype as those based by Mr. Carruthers on his independent studies, and thus brought Dr. Vaughan round to the same view. Mr. Carruthers has asked me to publish my confirmation of his conclusion, and to add one or two details that had escaped him.

The species *Caninia cornucopiæ* does not date from the Congrès de Turin. The report of that Congress appeared in, *Atti riuniane scienziati Ital.*, ii, Torino, 1841, pp. 227–228. *Caninia* was there defined as a fossil ally of *Cyathophyllum*, distinguished by infundibuliform tabulæ. No species was mentioned. The name *C. cornucopiæ* therefore dates from the paragraph by Paul Gervais, Dict. Sci. Nat. (De Blainville), Suppl. I, p. 185. This paragraph is quoted in full by Mr. Carruthers (p. 166). The life of the Supplement was cut short, and the plate therein referred to was never issued. In subsequent editions of the "Dictionnaire des Sciences naturelles," *Caninia* continues to be quoted by Gervais, with mention of *C. cornucopiæ* as the only species.

The date of the original Supplement is given as 1840, but was more probably 1841, since it must certainly have been published after the Congress was held at Turin, although it may have appeared before the actual publication of the *Atti*.

De Koninck (1841, Descrip. Anim. foss. terr. houiller . . . Belg., p. 22) did not accept *Caninia*, and made *C. cornucopiæ* a synonym of *Cyathophyllum mitratum* (Schlotheim). Since *C. cornucopiæ* had not then been published, De Koninck must have obtained his information from Michelin's letters or MS. This is further proved by the fact that De Koninck (loc. cit.) quoted the unpublished *Caninia cornu-bovis* as a synonym of *Cyathophyllum plicatum*. He may have got the name from the legend to the unpublished plate, since he quotes Dict. Sci. Nat., Suppl. II (not I). Anyhow, this citation gave *C. cornu-bovis* no validity.

The date of page 81 of Michelin's "Iconographie Zoophytologique" was probably about 1842. The species *Caninia gigantea* there established is said to be the only species common at Sablé, one of the localities ascribed to *C. cornucopiæ*, although erroneously, in the paragraph of Gervais.

As Mr. Carruthers points out, Michelin, when establishing *Caninia cornu-bovis*, referred to "Michelin, in P. Gervais, Astrée, Dict. des Sci. nat., Suppl. tome I, p. 485 (pour le genre)." By the last words Michelin seems to imply that the description published in Gervais gives the characters of the genus, but not those of the species *Caninia cornu-bovis*. Mr. Carruthers admits the possibility of an alternative interpretation, namely, "that the generic description in the Supplement should be regarded as a specific description of *C. cornu-bovis*." Such a weakening of his case seems to me quite unwarranted.

The reason for taking *C. cornucopiæ* as genotype is briefly that this species was definitely selected as "espèce type" in the Supplement (1840 or 1841); and although *C. cornucopiæ* was not fully described till 1846, no other species was proposed as genotype by Lonsdale or any other intervening writer. In such a case, the rules of the International Zoological Congress leave no room for doubt.

It is hoped that the few notes here given will complete Mr. Carruthers' account, without affecting its main conclusions.

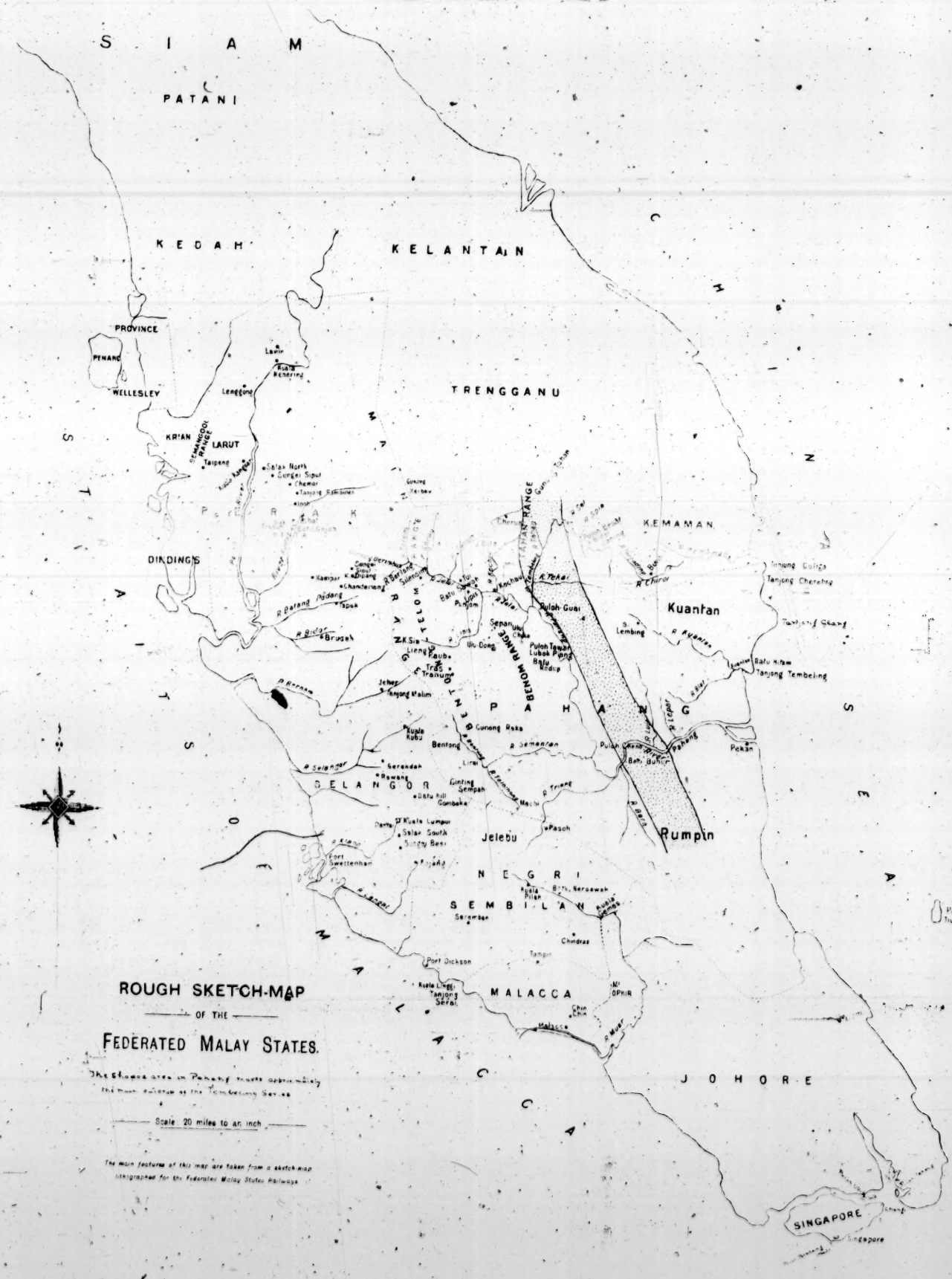
April 7th, 1908. F. A. Bather.

CHANGES OF LEVEL AND RAISED BEACHES.

Sir,—In the May number of this Magazine Dr. Jamieson suggests that the elevation of raised beaches is caused through the lightening of land areas by the ordinary denudation constantly going on. That this denudation may be a *vera causa* of elevation to re-establish equilibrium is highly probable. But there must be counteracting agencies at work, because the elevation of the beaches has been followed by a certain amount of depression, as shown by the submerged forests on our coasts. Denudation has been going on all along, and the land is now at its lightest, and consequently ought to be at its highest, yet on the contrary what was lately dry land is now below high water.

O. Fisher.

May 11th, 1908.



To illustrate Mr. J. B. SCRIVENOR's paper on "The Sedimentary Rocks of Singapore."